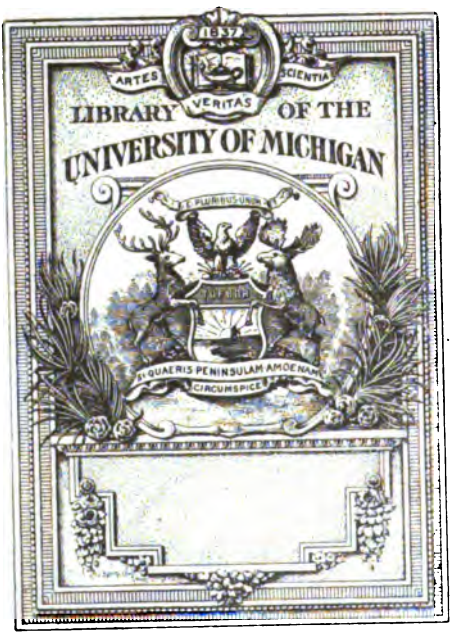

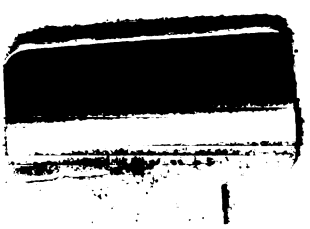

BULLETIN No. 19, NEW SERIES.
U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF ENTOMOLOGY.

SOME INSECTS

INJURIOUS TO GARDEN AND ORCHARD CROPS.

A SERIES OF ARTICLES DEALING WITH INSECTS
OF THIS CLASS.

PREPARED UNDER THE DIRECTION OF THE ENTOMOLOGIST,

BY

F. H. CHITTENDEN,
ASSISTANT ENTOMOLOGIST.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1899.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF ENTOMOLOGY,
Washington, D. C., January 21, 1899.

SIR: I have the honor to transmit herewith manuscript of a bulletin containing certain articles upon insects injurious to garden and orchard crops, which has been prepared by F. H. Chittenden, of this office. The articles all concern insects of very considerable economic importance and derive an especial value from the fact that they are, with few exceptions, based upon original observations made in the vicinity of Washington. The worker on economic entomology will find very many hitherto unreported facts concerning the life histories of the species treated, and the vegetable grower and orchardist will find many valuable practical points based upon this more intimate knowledge of the life histories of the insects. Seventeen of the twenty figures are here published for the first time.

I recommend the publication of this manuscript as Bulletin No. 19, New Series.

Respectfully,

L. O. HOWARD,
Entomologist.

Hon. JAMES WILSON,
Secretary of Agriculture.

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ILLUSTRATIONS.

PREFACE.

Under the comprehensive title, Some Insects Injurious to Garden and Orchard Crops, the writer has brought together a series of articles bearing upon insects of this class. These are in continuation of work begun in previous years, the results of which have found expression in Bulletin No. 10, in the Yearbooks for 1896 and 1898, and elsewhere, and are based upon observations conducted, for the most part, during the year 1898. At the same time there has been added, from the notes that have accumulated by correspondence and otherwise in this office, as matters of record, much that is new or unpublished concerning the food and other habits as well as the distribution of the species of insects considered.

In connection with the topics that are dealt with somewhat at length, the matter of remedies and other methods of control has received due consideration. The fact that this bulletin is to a certain extent a popular-scientific one has suggested the wisdom, as a means of enhancing its value to the practical worker, of the addition of a brief summary of remedies to articles that take the form of notes or incomplete accounts.

Late in the season of 1897 the subject of the insects affecting cucurbit crops was taken up as a specialty, and seven of the topics here discussed treat of this class of insects. In the course of investigations conducted in Maryland and Virginia and in the District of Columbia in the vicinity of Washington, the squash ladybird often came under observation, and it was found that a number of points of interest were omitted by earlier writers, and these, together with some descriptive and other notes necessary to the completion of the account, are brought together in connection with the illustrations as the initial subject of the bulletin. The life history of the common squash bug, *Anasa tristis*, although a well-known pest nearly everywhere, has not previously, to the writer's knowledge, been studied at all fully. The allied *Anasa armigera* has for the first time come under observation during the past two years as a species of economic importance, and has received attention in the same manner as its more common congener. The remaining four articles on cucurbit pests contain more or less information that has not previously been made public.

One of the most interesting of the injurious occurrences of the year 1898 was the discovery of an insect that is apt to prove of great economic importance in the course of time. This is an imported webworm, *Hellula undalis*, and it is at present troublesome to cabbage, turnip, and other cruciferous crops in the neighborhood of Augusta, Ga. The cultivation of these crops has been for many years a matter of extreme

difficulty in many sections, and in very recent years a complete failure in the District of Columbia and in many parts of Maryland, and the addition of a new pest from abroad is most unwelcome.

The study of *Halticus uhleri* is an outgrowth of investigations on insects affecting beans and peas. This species, though scarcely more than a second-rate pest, is deserving of further study as regards its life habits and the methods to be used in its control.

Some observations were made bearing upon the early life history of the imbricated snout-beetle, *Epicærus imbricatus*, but attempts to rear the larvæ were not successful. The observations which are here recorded, however, are of considerable interest, especially as regards the egg-laying of this species.

Rather remarkable success was attained in the study of the fruit-chafer, *Euphoria inda*, which was carried successfully through all its stages. The results demonstrate for all practical purposes that this species is not injurious except in the adult condition; a fact that has previously been surmised, but which had not been brought out with sufficient clearness in earlier investigations.

Nothing of a biologic nature has hitherto been published concerning one of our two commonest May beetles, *Lachnosterna arcuata*, which is here described and illustrated in its immature stages for the first time. Its life history is also given somewhat in detail, as well as notes bearing on its life habits and economy.

The unusual abundance of *Disonycha xanthomelæna*, the spinach flea-beetle, the past year led to a special study of this species, resulting in the discovery of a new food plant and the completion of its life history.

The article on the flea-beetles which attack tobacco, the potato and other solanaceous plants is a continuation of observations begun in 1897 and published in Bulletin No. 10.

The cherry leaf-beetle, *Galerucella cavicollis*, is one of the species which has been prominent as a pest during the last year, and has received in consequence some study. Until the past season it has not been injurious to the peach.

The article on the plum and rose leaf-beetles is in continuation of studies begun in previous years; which is true of the notes which are here presented on the fruit-tree bark-beetle and other fruit-tree borers.

It should be added, for the benefit of the bibliographer, that the title of this bulletin is simply assumed for convenience, and that, although each separate account is not signed by the author, each should properly be indexed separately, as each article is in itself complete, having no special bearing on either what precedes or follows it in the order of publication.

The illustrations were for the most part prepared from selected fresh material and, with a single exception, especially drawn or otherwise adapted for this work.

F. H. C.

SOME INSECTS INJURIOUS TO GARDEN AND ORCHARD CROPS.

THE SQUASH LADYBIRD; ITS LITERATURE AND BIOLOGY.

In the course of the investigations of the insect enemies of cucurbit crops, the squash ladybird (*Epilachna borealis* Fab.) has come under observation on numerous occasions. All of the different stages of the species have been described more or less fully by different writers; some few slight details in the life economy of the insect remained to be more fully studied, however, and in looking through the early literature of the species so much has been found of interest that has obvi-

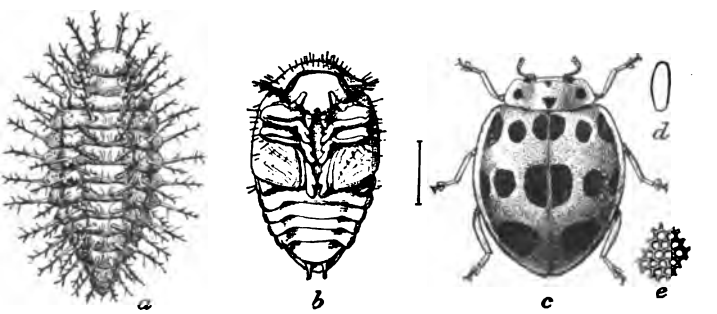


FIG. 1.—*Epilachna borealis*: *a*, larva; *b*, pupa; *c*, adult beetle; *d*, egg; *e*, surface of same—*a*, *b*, *c*, three times natural size; *d*, four times; *e*, highly magnified (original).

ously escaped the attention of some of the later writers, that mention is here made of it. Illustrations of the insect in its various stages and of its work are also presented, together with brief mention of its chief characteristics, its habits, and its distribution. As the bibliography has not hitherto been brought together, a list of the principal economic writings has been compiled and is appended.

GENERAL APPEARANCE AND DISTRIBUTION.

For the benefit of those who are not perfectly familiar with this insect and to facilitate its recognition with the aid of the illustrations, a brief description of its several stages is given as a preliminary.

The beetle is of the characteristic hemispherical form of ladybirds, ochraceous in color, with the dorsal surface marked with rounded black

spots, as shown in the illustration (fig. 1, *c*). The prothorax bears normally four spots, and each elytron has seven. The eyes, tips of mandibles, and metasternum are also black. The beetle measures about a third of an inch (8^{mm}), its length being about a fifth longer than its width (5.5^{mm}). The egg is yellow, about three-tenths of an inch (1.5^{mm}) long and of the elongate subcylindrical form illustrated at *d*. Its surface is somewhat pulverulent and sculptured as shown, highly magnified, at *e*. Eggs are deposited, usually in irregular clusters of from half a dozen to fifty or more, on the under surface of a leaf. In two large bunches observed 51 and 52 eggs were counted. The larva is yellow, like the eggs, and even when first hatched is covered with spines, arranged in six rows except on the first thoracic segment, where there are only four. A mature larva with its spiny armament is figured at *a*. The pupa, also yellow, is shown at *b*.

The species is indigenous to America and ranges from Maine and Canada in the north to the Gulf States. It is essentially an eastern form, occurring in the United States most abundantly along the Atlantic seaboard, and does not appear to be injurious west of the Mississippi River, although its occurrence has been reported in Kansas and Minnesota. It is also recorded by different writers from Mexico, Cuba, and the Antilles; Guatemala, Honduras and British Honduras; Nicaragua, Costa Rica, Panama, Colombia, Argentina, and Brazil.

The genus is tropical, all of the three species which are found in the United States being also native to Mexico, where the present species is widely distributed. In the latter country and Central America, the center of greatest abundance of the genus, many more species are known. The genus is remarkable as being the only one known in the great family Coccinellidæ, which is strictly herbivorous in all stages.

Judging by published accounts, personal inquiry and experience, this species is most troublesome in the following States, mentioned in approximate order of importance: New Jersey, New York (Long Island), Maryland, Alabama, Virginia, Pennsylvania, Connecticut, Massachusetts, and Georgia. It is also destructive, according to Mr. G. C. Champion, in Central America.

During the season of 1897 this species was observed to be present in destructive abundance only in one locality visited, at Glen Echo, Md., where it was found upon cucumber and melon as well as on squash, but by far more injurious upon the latter plant. In 1898 it was very generally injurious in Maryland and Virginia in the vicinity of the District of Columbia. It occurred in destructive numbers in nearly every field of cucurbits visited. The list of localities where it was observed includes the District of Columbia, on our experimental plat where the species probably survived the winter from specimens used in rearing experiments the year before; at Kensington, College Station, Poolesville, and Marshall Hall, Md.; Colonial Beach, and Norfolk, Va. In the last-mentioned locality it was reported very injurious by Dr. E. F. Smith, of this Department. It was destructive in the entire neighborhood of Norfolk.

COMMON NAMES AND SYNONYMY.

Quite a variety of English names have been applied to this species, each writer having seemingly bestowed upon it an appellation of his own coinage. Thus we have: Northern ladybird, boreal ladybird, boreal ladybird beetle, herbivorous lady bug, squash coccinella, spotted squash bug, and pumpkin beetle. The name of squash ladybird is adopted as more suitable than boreal or northern ladybird, either of which is peculiarly inappropriate, considering the fact that the species abounds in the tropics, belonging to a neo-tropical genus, and that there are several Coccinellids with a more northern range than this.

In our American literature this species is always mentioned under the specific name of *borealis*, either as Coccinella or Epilachna. It has also been described, from Central and South America, under other names, of which the following are recognized by Rev. H. S. Gorham as synonyms (Biol. Centr. Amer., Col., vol. VII, p. 241, Jan., 1898): *C. immaculicollis* Chevr., *E. æquinoctialis* Muls., *E. particollis* Muls., *C. 13-notata* Latr., *E. distincta* Weise. Of these *æquinoctialis*, *immaculicollis*, and *distincta* are well-marked color variations.

FOOD PLANTS.

The squash ladybird, as might be gathered from its name, is particularly fond of squash, upon which it feeds as larva and beetle. It may be found often in some abundance on the leaves of pumpkin, whence one of its vernacular names, pumpkin beetle, also on cantaloupe, watermelon, and cucumber, and it has two natural or wild food plants in the prickly cucumber or wild balsam apple (*Echinocystis lobata*) and the one-seeded bur cucumber (*Sicyos angulatus*). The larva feeds almost exclusively on the lower surface of a leaf, consuming the lower epidermis and parenchyma and leaving the upper integument, veins, and nervures more or less intact. The beetles feed by preference on the upper surface, although they may often be found on the under side, and devour all parts of a leaf except the veins.

The habit of this species of feeding in free exposure on the upper surface of leaves has been noticed by all who have studied it. This is its feeding habit, but during the heat of midday the beetles seek concealment under the shade of the leaves on the stems, and in other places where they are not so readily noticed. As the sun gets low, however, and a portion of their food plant is protected by shade, they come out in numbers. During the middle of July they have been noticed in the greatest abundance from between 5 and 6 in the afternoon until dark.

Late in the season the beetles sometimes eat the epidermis of the fruit of cucurbits. The injury to a plant is effected by the work of the larval and adult stages about equally, due to the long period of the latter stage.

Both larvæ and adults are slow of movement, the latter being seldom seen in flight.

HISTORY AND LITERATURE.

Epilachna borealis was first described by Fabricius in 1775 (Systema Entomologiæ, p. 82, *fide* Gemminger & Harold), and the first public mention of its habits that has come to the writer's notice is a short note in the American Farmer's Encyclopedia, edited by Gouverneur Emerson and published by A. O. Moore in 1858. It is there stated in brief that the leaves of squash are preyed upon by "*Coccinella borealis*." "Although the genus of insects to which this belongs destroys aphides, there are, as Professor Halde[r]man, of Pennsylvania, observes, a few exceptions, among which is the species named, which may be found in the larva and perfect state, eating the leaves of the squash." Haldeman's note, if published, can not be found in any literature at my disposal. This notice was followed by a very good article by Moore in the Country Gentleman for April 1 of the same year. This latter covers two columns and is illustrated with seven crude but fairly good original figures.

FIG. 2.—Work of *Epilachna borealis* on a squash leaf—natural size (original).

The first detailed description of the early stages of the species appears to have been published ten years later by Dr. S. H. Scudder (Amer. Jour. Hort., vol. III, pp. 80–82, etc.). Shorter notes, however, bearing upon its biology appeared in earlier years. In 1883 Prof. G. H. French also published descriptions of the insect in its different stages, and in 1886 Mr. S. S. Rathvon contributed an interesting article containing some original observations. In more recent years the species was made the subject of special study by Prof. J. B. Smith, of the New Jersey Agricultural Experiment Station.

A list of the principal writings is given as an appendix to the present paper, to which reference may be made for further information.

The curious and perhaps characteristic habit of this genus of ladybirds of feeding within a circumscribed space on a leaf is interesting, but for some reason has not received very general notice by entomologists who have had occasion to write of this insect in recent years. On this head Mr. Moore wrote: "It has a singular habit which I have noticed in no other insect. In feeding, the first act is to mark out with its forceps a circle or semicircle, sometimes of great regularity, inclosing the portion of the leaf on which it is about to feed. The leaf is then eaten within this mark and nowhere else."

The object of the insect in thus "staking out a claim," as some one has termed it, is obviously to secure the wilting of the tissues of the leaf previous to its consumption. A portion of a squash leaf showing the work of this insect is reproduced in figure 2.

Rathvon cites an interesting instance of the capture of "between four and five hundred of these beetles, in the month of March, under the bark of an old tree that stood in a field where corn and pumpkins had been cropped the preceding year. * * * Perhaps fifty of them had crawled out and were basking in the sun."

NOTES ON THE LIFE HISTORY.

The first adults observed in the vicinity of the District of Columbia during the season of 1897 were seen June 25, but there is no doubt that they occur earlier, as beetles are stated to appear near New York City early in June. Newly hatched larvæ were found July 1.

Eggs deposited in confinement June 26 hatched July 3, or in seven days; temperature, 80°. F.

To ascertain the other periods of the insect, adults were placed June 26 upon squash vines on our experimental plat, that were free from this insect, and it is presumed that eggs were laid the first day. Of this lot some larvæ had attained full growth by the 18th of July, or in twenty two days. One individual was noticed to cease feeding at this date and attach itself to a leaf, and the following day it transformed to pupa. From this pupa the first adult of the first brood issued July 25, six days from the time it had transformed to pupa; weather reasonably warm, 84° to 88° F. This gives a period of development as follows: Egg, seven days; larva, sixteen days; pupa, six days—a total of twenty-nine days from egg to beetle.

Writing in 1883, Prof. G. H. French estimated that in Carbondale, Ill., this species has a period from the egg to the imago of thirty-five days. As this insect occurs in colder climates and the minimum midsummer periods of development were not observed, we have for the species an approximate development: For the egg, six to nine days; larva, sixteen to twenty-four days; pupa, six to nine days.

French does not state definitely how many times the larva molts, but as he speaks of four larval periods it is to be presumed that three are assumed. Rathvon, some of whose statements, it must be said, have to be taken *cum grano salis*, as the data furnished are really insufficient for the establishment of the facts, says: "The larva molts five times (perhaps more)."

NUMBER OF GENERATIONS ANNUALLY.

Experience has shown that if we would have the proper regard for accuracy the statements of many of the earlier writers (and some of the later ones) must not always be interpreted literally. Too often an account of an insect is written in florid style and too frequently conclusions are based upon the most superficial observation. Thus it happens that Moore was led astray when he stated that this insect "may be found upon the squash vine of all ages at once from the first of July to the middle of October, showing that *many successive* broods are

hatched irregularly through the summer," and Rathvon also in his conclusion that there were not less than "three generations annually, although there appeared to be a dozen."

From frequently finding the insect in different stages, early and late, the conclusion that two or more generations were produced each year is only natural. Dr. Smith makes mention of the number of generations in the following words: "Exceptionally, specimens matured early in August *may* mate and oviposit; but such cases are rare, I believe."

Twenty beetles of the new generation were placed by the writer on a squash plant at Washington, August 7, and covered with netting. After a time, during a severe rain, the covering was removed, and when next examined the beetles had disappeared and no eggs were to be found. Indications are therefore that the species is single-brooded.

EARLY AND LATE OCCURRENCES.

A season's observations met only partial success in the ascertainment of what might naturally be considered matter of easy accomplishment. This exemplifies the futility of drawing conclusions on the entire life history of an insect from a single season's observation in a somewhat limited locality, and yet little better should be anticipated from a species so local and periodical in its attack.

In the first place, a sharp lookout for the first appearing adults resulted in their discovery June 25, within two or three days of their first appearance; yet this date is not so early as that already recorded for New Jersey and southern New York.

Dr. Smith observed in one season in New Jersey that "by the beginning of September all traces of the species had disappeared from the fields." In the season of 1886 the writer saw this insect in great abundance, September 5, on squash near Springlake Beach, N. J., from one to a dozen beetles on a single leaf. Larvæ were also present, and pupæ were observed as late as September 15.

Here, near Washington, the past season the beetles were noticeably less abundant in September, practically disappearing with the death of their food plants, about the middle of the month. Two stragglers, however, were seen as late as October 6 on a belated watermelon vine.

NATURAL ENEMIES.

In Moore's article an insect is figured and described as in several instances having been found preying upon the larva of this Coccinellid "by inserting its proboscis in the body of the latter and sucking out its contents." The illustration which is given of this insect in the act of destroying its victim is perfectly recognizable as the spined soldier-bug, *Podisus spinosus*, or a closely related species of the same genus, which includes some well-known enemies of leaf-feeding coleopterous larvæ. The tachina fly, *Euphorocera claripennis* Macq., has been reared as a parasite of this species, having issued from the larva in August and September.

The beetle exudes the disagreeable and characteristic odor of the ladybird family, and this undoubtedly serves as a measure of defense against predatory birds and other enemies.

SUMMARY OF THE LIFE HISTORY.

The life history of this species as at present known, from the District of Columbia northward, may be summarized as follows:

The insect hibernates in the adult condition under bark or other convenient shelter and appears abroad some time in May or June, the date being subject to considerable variation in different seasons as well as in locality. Egg deposition has been observed in the latter part of June, and there is evidence that eggs are deposited also much later. They hatch in from six to nine days and the larvæ begin to feed at once upon the leaves, causing them to wither and die. The exact number of molts of the larva has not been ascertained, but there are evidently either four or five larval periods. The larva attains full development in from two to four weeks, ceases feeding, and attaches itself by its anal extremity to a leaf, and next day sheds its larval skin, which is pushed down toward the end of the body, when the pupa stage is assumed. The larva matures any time from the middle of July to near the middle of September. In the pupa state the insect remains from six to nine days, when the pupal skin separates down the back and the perfect beetle emerges, the new brood appearing as early as the last week of July. After feeding for some time the beetles disappear for hibernation, the date of disappearance beginning about the middle of September, although individuals are occasionally found later.

ECONOMIC STATUS.

Compared with three-score or more of other species of our noxious insects, the squash ladybird is hardly entitled to more than secondary rank. That it is capable, when present in sufficient numbers, of inflicting severe injuries can not be gainsaid, but published records and, more especially, recent investigations go to show that it is only in exceptional seasons and in rather limited areas that the inroads of the larvæ and beetles upon the foliage of cucurbits result in material loss. Some reasons for this may be adduced: First and foremost, the species is not particularly prolific. Most injurious insects produce several generations a year. With the present species there is no indication of more than a single brood annually. Second, all stages of the insect occur freely exposed on the plant, and as all are large and conspicuous, they are subject to the attack of other insects and other natural enemies. In spite of the so-called "warning colors" of this insect and of the obnoxious fluid it exudes when disturbed, we know that it has two insect enemies, and probably has several more. Third, the genus is, or at least was, a tropical one, and the species probably reaches its highest development in or near the Torrid zone, and, like other tropical

insects, its hibernation, as already shown by the observations of Rathvon, previously quoted, is not as complete as in the case of boreal species.

There can be little doubt that this beetle sometimes acts as a transmitter of the bacterial wilt of cucurbits the same as is known to be the case with the cucumber beetles and common squash bug, which fact is to its discredit.

The presence of the squash ladybird, although a pest of secondary importance, is certainly not desirable in a field of melons, squashes, or other cucurbits. With the beetles and their larvæ devouring the leaves, the larvæ of Diabrotica at the roots, or the vine-boring Melittia larvæ in the stem, and the plant-louse or odoriferous squash bug sapping the vitality of leaves and leaf stalks, this ladybird can not be otherwise than harmful. Only too often several or all of these insects work in unison to the detriment of a plant, hence the suppression of even one of these enemies may sometimes be sufficient to enable the plant to recuperate.

REMEDIES.

Remedial measures that are adopted for other cucurbit pests will at the same time effect the destruction of this ladybird. Its habit of feeding both as larva and adult freely exposed on the leaves renders it peculiarly vulnerable to poisonous applications, and of these the arsenites, either dry or in solution, are the best. Hand-picking of the beetles and egg masses, considering their large and conspicuous appearance, is an easy manner of riddance of the nuisance if employed on the insect's first appearance, and is the only measure necessary under any except unusual circumstances. Both larvæ and beetles are decidedly sluggish in habit and hence are easily captured.

PRINCIPAL ECONOMIC WRITINGS.

1. FABRICIUS, JOH. C. <Systema entomologiæ, p. 82 (*fide* Gemm. & Har.), 1775.

Original description of the species as *Coccinella borealis*.

2. EMERSON, GOUVERNEUR <American Farmer's Encyclopedia, 1858, p. 1012.

A brief statement that the larva of *Coccinella borealis* preys upon the leaves of squash.

3. MOORE, A. O. <Country Gentleman, April 1, 1858, p. 210, figs. 1–7.

A two-column popular account with seven original figures.

4. OSTEN SACKEN, C. R. <Proceedings Entomological Society Phila., v. I, p. 125. 1862.

Larva briefly compared with congeneric species described by Chapuis and Candèze; stated to agree in all essential characters except that there are only three distinct ocelli, the fourth being extremely minute.

5. SANBORN, FRANCIS G. <10th Annl. Rept. Secy. Mass. Bd. Agriculture for 1862 (1863), p. 146, fig.

Popular half-page account, with apparently original illustration of beetle. Observed in "interior of partially decayed squash" at Barnstable, Mass.

6. WALSH, B. D. <Practical Entomologist, v. I, p. 111. Aug. 27, 1866.

Answer to correspondent in Pennsylvania; larva on squash.

7. WALSH, B. D. <Practical Entomologist, v. II, p. 42, fig. 1867.

Brief mention, introducing an apparently original figure of the adult.

8. SCUDDER, S. H. <American Journal Horticulture, Feb., 1868, v. III, pp. 80–82, fig. <23d Annl. Rept. Ent. Soc. Ontario for 1892 (1893), pp. 78–79, fig.

Description of the larva, pupa, and beetle, with brief notes on the habits of the species in Massachusetts and Connecticut.

9. WALSH, B. D., and RILEY, C. V. <American Entomologist, v. I, p. 39. Oct., 1868. Fig.

Briefly stated to be "very injurious in the Eastern States to the fruit and foliage of the squash."

10. RILEY, C. V. <American Entomologist, v. II, p. 375. 1870.

Answer to correspondent who sent larvæ on squash from Philadelphia, Pa.

11. FITCH, ASA. <Illustrated Annual Register of Rural Affairs for 1867–68–69 (1873), v. V, pp. 202–204. Figs.

A short account based upon No. 3; the species stated to be common in southern New York and Connecticut.

12. PACKARD, A. S. <Report U. S. Geological Survey, 1875 (1877), p. 772. <Amer. Nat., v. II, pp. 22–29. Jan., 1877.

Quotes Osten Sacken. A few-line notice.

13. FRENCH, G. H. <Canadian Entomologist, v. XV, pp. 189–191. 1883.

Describes the egg, larva in four stages, and pupa; on the prickly cucumber, or wild balsam-apple (*Echinocystis lobata*); habits and periods briefly mentioned.

14. RATHVON, S. S. <Gardener's Monthly, v. XXVIII, pp. 372–373. Dec., 1886.

A general, somewhat detailed, account of four columns, recording some interesting and original observations concerning the life economy of the species, including a new food plant, *Sicyos angulatus*.

15. SMITH, J. B. <Report New Jersey Agricultural Experiment Station for 1890 (1891), pp. 483–484, fig.

A short account; beetle abundant at Jamesburg, N. J., on pumpkin, etc.; original illustration of larva and adult.

16. LINTNER, J. A. <Seventh Report New York State Entomologist, pp. 310–311. 1891. Fig. (after Emmons).

Quotation from a correspondent at Dosoris, L. I., with brief notes.

17. SMITH, J. B. <Insect Life, v. IV, p. 44. Oct., 1891.

Abundance in New Jersey; brief note.

18. SMITH, J. B. <Insect Life, v. V, p. 98. Nov., 1892.

Brief notice of increasing injuriousness in New Jersey; carnivorous tendency of newly hatched larvæ.

19. HOWARD, L. O. <American Gardening, v. XIV, p. 210. April, 1893.

Short popular account.

20. SMITH, J. B. <Entomological News, v. IV, pp. 123–125. April, 1893. Figs.

A note discussing the relative differences between the mandibular structures of the herbivorous *E. borealis* and the carnivorous *Coccinella 9-notata*, illustrated with two original figures.

21. SMITH, J. B. <Entomological News, v. IV, pp. 197–199. June, 1893.

An epitome of the life history and habits of the species, with three original photographic illustrations of all stages and work.

22. SMITH, J. B. <Bul. 94, New Jersey Agl. Exper. Station, pp. 410. July 2, 1893. Figs. <Rept. N. J. Agl. Exp. St. for 1892 (1893), pp. 476–482.

A six-page illustrated account.

23. SMITH, J. B. <Insect Life, v. VI, p. 187. Dec. 8, 1893.

Brief mention of the rarity of the species in New Jersey in 1893.

24. [SIRRINE, F. A.]—Bul. 75, n. s., N. Y. Agl. Expt. Sta., pp. 419–420.

Short popular economic account, with original figure of beetle. The species stated to be "becoming more and more abundant every year" on the western half of Long Island.

25. KEY, T. J.—Southern Agriculturist. July 15, 1895.

Correspondence with T. C. Dawson, who sends specimens "that are destroying the melon vines" at Wetumpka, Ala.

In addition to the above, brief popular accounts are given in the following text-books: Packard's Guide to the Study of Insects; Smith's Economic Entomology; Comstock's Manual for the Study of Insects. In the last-mentioned publication (p. 536) an original illustration is furnished of the insect in three stages.

LIFE HISTORY OF THE COMMON SQUASH BUG,

(*Anasa tristis DeG.*)

THE NUMBER OF STAGES IN HETEROPTERA.

Examination of a lot of *Anasa armigera*, obtained in all stages in the latter days of September, 1897, failed to discover more than four distinct stages in addition to the egg and adult, although there was more than a suspicion that at least one other stage was present. Owing to the lateness of the season the species could not be followed through all its molts.

The late Dr. Riley, in his Seventh Missouri Report (p. 21), and in the report of this Department for 1887 (p. 59), in treating of the chinch bug, *Blissus leucopterus*, mentions only the newly hatched larva, the larva after the first molt, and after the second molt, and the pupa, or four preparatory stages in addition to the egg. Three of these stages are figured on plate I of the report of this Department for 1887. Prof. S. A. Forbes, in his report as State entomologist for Illinois, for the year

1883 (1884, pp. 119, 120), figures and describes four stages of the tarnished plant-bug, *Lygus pratensis*. Of the different stages of the cotton stainer, *Dysdercus suturellus*, Messrs. Riley and Howard remark in Insect Life (vol. I, p. 236), that among the material sent to the Department four preparatory stages were distinguished, "which undoubtedly represent separate molts, and, from the gradation in size, probably represent the complete life of the insect." These four stages are illustrated, as also what is doubtfully believed to be the newly hatched nymph. Other instances of the recognition of four nymphal stages might be cited, but the above will serve to define the trend of opinion on this topic until recent years.

In none of the works consulted, except those of comparatively recent date, did the writer find mention of the occurrence of more than four stages in the growth of Heteroptera, except in Mr. M. V. Slingerland's bulletin on the four-lined leaf-bug (Bul. 58, C. U. Agl. Expt. Sta., Oct., 1893), and in Mr. A. L. Quaintance's bulletin on strawberry insects (Fla. Agric. Exp. Station, Bul. 42, August, 1897, pp. 566–574). In the former bulletin five stages of the Capsid, *Pœcilocapsus lineatus*, are figured and described, and in the latter, *Pamera vincta*, a small Lygaeid, is similarly treated.

At the opening of the season of 1898 an attempt was made to find a sufficient number of the adults of *Anasa armigera* to observe all the different stages and molts. As this effort at first met with failure, it was determined to make the same experiment with *A. tristis*. As a result, five distinct stages, in addition to the egg and adult, were observed. Later the same five stages were recognized in *A. armigera*. It is somewhat surprising that the existence of these five stages were not known to earlier writers. This may be accounted for in most cases perhaps by the failure to recognize a difference between the second and third stages and less frequently between the third and fourth.

Some zoologists, among others Messrs. Comstock and Quaintance, consider all of the immature active stages of Heteroptera as nymphs. On the assumption that the difference between the larvæ and the nymphs consists in the absence or presence of wing-pads, it is often a matter of considerable difficulty to separate the one from the other. According to this definition, the stage just previous to the last molt before the adult stage is assumed is always a nymph, as is also the stage just previous to this, but the two stages between this last and the first, or so-called larval stage, are difficult to define. Practically all stages in some species have either wing-pads or at least the semblance of them.

It should be remembered that the descriptions and measurements that will be given of *Anasa tristis* apply to the nymphs immediately after molting, this being the time taken for the descriptions. There is practically no difference between the length of the body just before and immediately after molting.

The life history of this species, as determined by observations of the past summer, is presented herewith.

THE EGG AND OVIPOSITION.

The egg (fig. 3).—The egg is shining and dark coppery or bronzy brown in appearance, being whitish when first laid, but soon changing to light yellowish-brown, and just before hatching to dark bronze. It is flattened on three sides; viewed from either end (*b*) it is triangular, while the base or side of attachment (*a*) is strongly concave, rounded at its sides and narrowed at each end, near the middle being provided with a nipple, the evident point of attachment. The surface is apparently nearly smooth, but when magnified is seen to be reticulated, being composed of a network of minute and very regular hexagonal areas (*c*). The length is nearly a half greater than the width, and the greatest depth is about the same as the width. Length, 1.55^{mm}; width, 1.05 to 1.10^{mm}.

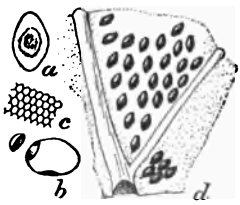


FIG. 3.—Egg of *Anasa tristis*: *a*, from below, showing point of attachment; *b*, from side, showing place of escape of nymph; *c*, sculpture of egg; *d*, egg cluster—*a*, *b*, about five times natural size; *d*, one-fourth enlarged; *c*, greatly enlarged (original).

Oviposition.—Eggs are deposited in more or less regular rows, with a tendency toward the alternate regularity of checkers laid on the black or white spaces, as in the case of the large mass figured at *d*, but sometimes they are disposed much less regularly and may be closely crowded together, as in the small mass also figured at *d*, or they may be quite widely separated. Egg masses are deposited usually on the lower surface of a leaf, but very often also on the upper surface and on the stems. When laid on the under surface between two veins the mass is apt to be compact. A mass before the writer consisting of about twenty eggs occupies a space of but little less than one-fourth of an inch square, while another mass of the same number requires a space nearly 1¼ inches square. Normal oviposition is in rather large masses of from twenty to forty, or more, but small masses and even eggs laid singly are often found.

The nymph makes its escape by forcing a hole through one end of the egg, as shown at *b* of figure 3.

DIFFERENT STAGES OF THE NYMPH.

First stage (fig. 4, *a*).—When newly hatched the larva is an attractive little creature; the body is light green, with the legs, antennæ, and haustellum a beautiful rose color. The head and the anterior part of the thorax is lighter rose and the eyes darker; in a few hours these parts with the entire thorax turn black. The body is elongate subovate, the head subtriangular, rather bluntly pointed, the apex of the abdomen a little more acute. The antennæ and legs are subequal and of nearly the same length as the entire body. The four joints of the

antennæ are subequal in length. The first and second joints are subcylindrical; the first widest, the third and fourth fusiform, the third a little wider than the first, and the fourth widest. The antennæ as well as the legs are quite hairy. The dorsal tubercles of the abdomen and the marking of the abdomen are indicated in the illustration.

The length of the body when the nymph is first hatched is a trifle less than 2.5mm, which becomes just prior to the first molt about 3mm or the same length as the next stage immediately after the molt.

Just before each molt the nymph becomes stouter, the abdomen very much rounded as if swollen, and the color lighter.

Second stage (fig. 4, *b*).—After the first molt the abdomen becomes a light pruinose gray and the tubercles and all markings become more pronounced and conspicuous; the head loses somewhat its triangular appearance, the eyes show more prominently at the sides, and the third joint of the antennæ is noticeably largest. The thoracic portion is now comparatively smaller and lighter in color. Immediately before molting the abdomen becomes very much enlarged, as though swollen, the color turns nearly uniform lighter pruinose gray, looking almost white, and the sutures of the upper surface of the head are nearly invisible. Length when first molted, a little more than 3mm.

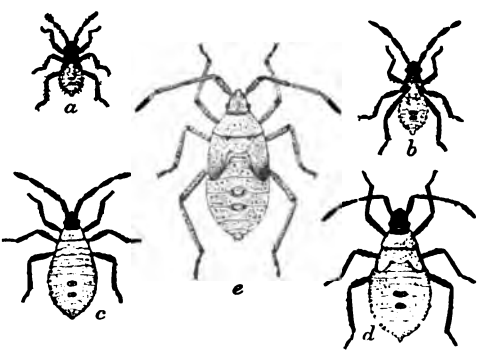


FIG. 4.—*Anasa tristis* nymphs: *a*, newly hatched; *b*, second stage; *c*, third stage; *d*, fourth stage; *e*, fifth stage—all about twice natural size (original).

Third stage (fig. 4, *c*).—After the second molt the larva has changed but slightly except in size and in the darker color of the body. The legs and antennæ have increased in length, maintaining the same relation to the body as at the first day of the preceding stages; in other words, the third larval stage is a nearly exact counterpart on the day of molting of the second larval stage on the same day in its development. Immediately before molting, however, it undergoes considerable change, presenting the appearance shown in the illustration. Length, about 4mm.

Fourth stage (fig. 4, *d*).—In the stages previously described the scale-like process which represents the wing-pad of the fifth or last nymph stage increases slightly with each molt. With the molt which ushers in this stage this process shows considerable growth, approaching closely to the true wing-pad of the next stage. The next most observable difference between this stage immediately after molting, and the previous stage at the same period of growth, is in the increased width of the thoracic and abdominal portions and the general darker color of the body; the body is nearly pyriform in shape. Length when first molted, 6 or 7mm.

Fifth stage (fig. 4, *e*).—The last nymph stage is so distinct from all previous stages that a description is scarcely necessary, as this form is sufficiently shown by the illustration. It is characterized chiefly by the increased growth of the thorax, which is now longer as well as wider at the base, and more particularly by the lengthening of the wing-pads—two changes which produce an increased semblance to the mature bug. The hairiness of the legs and antennæ which was so pronounced in the first stage has gradually become less and less evident with each successive molt until the hairs now, although plentiful, are little more than fine short bristles. Length when first molted, 9 or 10^{mm}, just twice as long as wide.

BRIEF DESCRIPTION OF THE ADULT.

To complete our knowledge of the different stages of this species the accompanying illustration of the adult is added. Figure 5, *a* represents a female bug, about twice the natural size. It measures a little less than three fourths of an inch (14 to 16^{mm}) in length, is dirty dark brown above and mottled yellowish beneath. The haustellum, seen in the profile of the head and thorax (*b*), passes when at rest under the body. The terminal segments of the abdomen of the sexes are shown at *c* and *d*, the former representing the male, the latter the female.

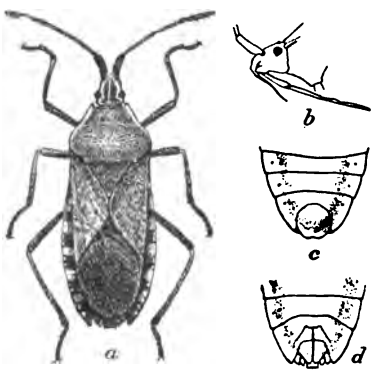


FIG. 5.—*Anasa tristis*: *a*, mature female; *b*, side view of head, showing haustellum; *c*, abdominal segments of male; *d*, same of female; *a*, twice natural size; *b*, *c*, *d*, slightly more enlarged (original).

THE PERIODS OF THE LIFE CYCLE.

The carrying of this species through all its stages in the rather close confinement of small rearing jars gave variable results in the periods. Only two of these, the egg and the first stage of the nymph, were at all constant for the same temperature.

The egg period was found to vary from eight to thirteen days, this period depending as do other periods on the exposure to heat or cold, dryness, or humidity. The later periods were also influenced perhaps by the food supply. The usual period of the egg is between nine and ten days.

The first nymph stage requires a period of three days, or a little less; the second was passed in eight and nine days; the third in seven and eight days; the fourth consumed six days for this period; and the fifth stage required eight days.

As some of the nymphs died in confinement, a number of this lot that had recently hatched were placed, July 3, on a squash plant on the experimental plat connected with this Division on the Department grounds. From these, three adults, the first observed of the season,

were obtained July 31, from nymphs taken from the field while in the fifth stage. This lot had completed its life cycle from the hatching of the egg to the emergence of the nymph from the last nymph skin in twenty-eight days, or in exactly four weeks. From the lot kept in confinement, from thirty-two to thirty-four days were required. We may then set the aggregate of its nymph periods down as between four and five weeks for this latitude. The egg period was ten days, which would give thirty-eight as the total ascertained period in days of the complete life cycle.

The first eggs of the season of 1898 were taken at Marshall Hall, Md., June 18. The first nymphs hatched June 27. Eggs that were laid June 19 hatched July 1, or in twelve days. As the weather was very hot during several days of this period, the time of first egg-laying in this locality that year may be safely placed at June 13.

After the first week of August adults of the old generation had practically disappeared, none being found when sought for, yet during the second week a number of egg masses newly laid were observed which must have been deposited by the adult bugs, as none of the many bugs reared in confinement laid eggs, and there is positively no evidence of more than a single generation produced each year. This is the condition in the District of Columbia and northward, and it is not unlikely that the same conditions prevail in the South, notwithstanding a statement which has been made by an entomologist of one of the Southern States that "several successive broods are raised during the season." It is not impossible, however, that an attempt is sometimes made in exceptional seasons like that which has just passed to produce a second generation but there is no possibility of such developing through the fact that there is no food supply, and further because of the frosty weather which always ensues during the latter part of October and during the month of November. A single instance of either protracted development or a futile effort to produce a second generation was observed the past year. A nymph in the third stage of its growth was taken on a squash vine October 13 and kept in a considerably warmer indoor atmosphere until November 9, at which time it had reached only the fourth stage of development. It would eventually have perished if it had been left upon the vines where found.

NATURAL ENEMIES.

In spite of the somber color of this insect, its quiet and secluded habits, and its offensive odor, it is not without its natural enemies. The majority of predaceous animals, however, including insects, are generally believed to avoid it.

The number of nymphs of this species on our experimental plats the past season being entirely out of proportion to the large number of egg masses previously observed, the writer became suspicious that some outside agency was at work in depleting the numbers of this insect.

Toads being rather frequently met with, fell under suspicion, and accordingly one was captured and was dissected by Dr. Sylvester Judd, of the Biological Survey of this Department, with the result that only a single specimen of this species in its adult condition was found. The toad has been previously recorded as an enemy of this insect by Mr. A. H. Kirkland (Bul. 46, Mass. Agric. Coll., p. 26). The squash bug is evidently not relished by toads, although it sometimes forms a portion of the food of this Batrachian.

A tame lizard (*Sceloporous undulatus*) when fed upon squash bugs devoured them readily in spite of the powerful odor which the bugs exhaled. One bug, however, sufficed for a meal.

None of the eggs that came under observation early in the season were parasitized, but toward the end of the season of the hibernated bugs, two species of parasites were observed. None of the egg clusters gathered for the purpose of rearing the parasites gave out these insects except where the parasites themselves were captured with the eggs. The parasites reared were referred to Mr. W. H. Ashmead who identified them as *Hadronotus anasæ* Ashm. and *Ooencyrtus anasæ* Ashm. The first of these was described under the genus Telemomus, and the latter under Encyrtus (see Bulletin No. 14, old series, p. 23). According to Mr. Ashmead, 30 per cent of the eggs of this bug collected by him in Florida were parasitized by the Hadronotus. They were reared there in June and July. None of the parasites observed in the neighborhood of the District of Columbia issued earlier than the last day of July, and the majority appeared considerably later in August, the last individual issuing August 23. The two parasites appear to have the same seasons, and their arrival on the field, judging from past seasons' observation, is too late to be of any great service.

The same is true as regards *Trichopoda pennipes*, the well-known dipterous parasite of the adult squash bug. Although these flies appeared soon after the advent of the bugs and in considerable abundance, they seemed to accomplish little in the direction of reducing the numbers of their host. The writer's attention was called to the fact that a majority of the parasitized bugs were female, but too late, unfortunately, to determine what effect this had upon egg-laying. The parasitized individuals were not noticed to die much earlier than those which succumbed to natural causes.

Anasa tristis is credited with having cannibalistic tendencies, but although the writer has had under observation several hundred individuals of this species, this habit has never been noticed. A single individual was observed, however, with a dead nymph of *Leptoglossus oppositus* suspended from its beak.

August 6, 1898, the writer noticed an individual of *Anasa tristis* affected by an entomogenous fungus which appeared upon the upper surface of one of the antennæ. It was referred to the Division of Vegetable Physiology and Pathology, and Mrs. Flora W. Patterson stated

that the interior of almost the entire body and all of its appendages were pervaded by the mycelium of the fungus, which, however, was not in condition for satisfactory identification. It was stated to be "probably a conidial stage of some Cordyceps, a *Sporotrichum* sp."

This squash bug is also subject to the bacterial disease, *Bacillus entomotoxicon* Duggar.

NORTHERN LIMIT OF THE SPECIES.

A letter from Dr. C. H. Fernald, dated January 19, 1899, is of unusual interest as bearing upon the northward progress of this species. He writes that during the fifteen years he was at the University of Maine, at Orono, the squash bug did not occur there nor at Mount Desert, nor in any part of eastern or northern Maine, so far as he could learn. He received specimens from Auburn, Me., where the species was said to be common, also from Waterville, which was the most northern and eastern place in Maine where it occurred in his experience.

Prof. F. L. Harvey, who has had opportunity of observing this species in more recent years in Maine, has written us of its occurrence in Orono, which is about 25 miles farther north and considerably farther east than Waterville.

ECONOMIC STATUS.

It seems not improbable that injury by this squash bug is somewhat exaggerated in many reported cases, the damage observed being often due to other insects which are less apt to be noticed. We seldom find less than three or four forms of injurious insects present at the same time upon an infested plant, and this squash bug, on account of its large size, is more apt to attract attention than are the much smaller but more destructive striped cucumber beetle and melon louse; the squash-vine borer, by reason of its concealed manner of living within the vines, is not so readily detected, and the result is that the squash bug receives the blame for the depredations of the others.

An instance of the nature described was reported by a correspondent at Sioux Falls, S. Dak., who wrote November 25, 1898, that this species, specimens of which were sent, was the cause of the loss of about two hundred vines of squash and pumpkins. The mature bug was reported to bore in the vine, sucking out the sap. "A vine would appear all right one day and the next would be flat on the ground, wilted as if killed by frost," evidence of the presence of the vine borer.

METHODS OF CONTROL.

This squash bug, particularly the adult, is unusually resistant to insecticides. A wash strong enough to kill the mature insect will at the same time destroy the vines. This renders it necessary to employ hand and cultural methods.

A number of the remedies in use against the striped cucumber beetle, as already outlined in Circular No. 31, second series, will assist in

the destruction or control of the common squash bug. Among these are: Protection of young plants with coverings; repellents, such as land plaster or gypsum saturated with kerosene or turpentine; planting an excess of seed to distribute attack; stimulating the growth of the plants by manure or other fertilizers, and, lastly, clean cultural practice.

If the precaution be observed of gathering the vines as soon as the crop is harvested and burning them, many bugs in their different stages will be destroyed and the crop of insects reduced for the ensuing year.

Of other methods in general use against this species are hand-picking early in the season and the trapping of the bugs by means of boards, pieces of bark, or similar material, placed about on the ground in the garden.

Protection to cucurbits other than squash and perhaps pumpkin can be secured, as was demonstrated during the past two years in the writer's experience, by growing these plants with the others to serve as trap crops. Attack will thus be centered upon a few plants, where the insects can be more readily controlled by the measures already mentioned. As corroborative of the above statement, it may be mentioned that Mr. E. L. Horton, jr., East Steamburg, Schuyler County, N. Y., wrote May 24, 1898, that this species would not touch cucumbers if there were any squashes in the neighborhood. In our correspondent's experience this species showed a preference for squashes over pumpkins, and of pumpkins over cucumbers and melons.

THE HORNED SQUASH BUG.

(*Anasa armigera* Say.)

RECENT OCCURRENCE.

July 12 and 13, 1897, *Anasa armigera* Say was observed by the writer near Colonial Beach, Westmoreland County, Va., on cucumbers. A lookout was kept for the species from that time, with the result of its being taken by the writer and Mr. F. C. Pratt, who assisted in field work, on August 2 at Poolesville, Md., on squash; August 10 at Seat Pleasant, Md., on cantaloupe; and later at Ballston, Va., on cucumber. August 25 it was found on cucumbers also, on the Conduit road, District of Columbia, and a few days later it was taken in all stages at Tennallytown, D. C., at which place it occurred in great numbers, doing perceptible damage to a late crop of cucumbers. On the 29th of September this insect was again observed at the latter place on watermelon in all stages, from egg to adult, hundreds being found on a single vine. All of the other cucurbits on this and neighboring farms had been harvested and the vines pulled up, which fact will, in a measure, account for the numbers of the insect at this time. In every instance where observed these bugs were associated with *Diabrotica vittata* and

other well-known enemies of Cucurbitaceæ, and they undoubtedly contributed their quota that year toward injuring these crops. On the last date mentioned they outnumbered all of the other insects, although the cucumber beetle was present in such numbers as to have left large holes in every leaf that could be seen. After the end of September no more specimens could be found, as cucumbers were mostly turned under and the stems and leaves of squashes and similar plants were dried up.

The first observed date of the occurrence of this species in the neighborhood of the District of Columbia was July 8. On this day of 1898 the writer found specimens on the experimental plats of cucurbits on the grounds of the Department of Agriculture, and Mr. Pratt took one at Poolesville, Md. Subsequently other individuals were found on the experimental plats, and it is probable that these were the offspring of a number that were left on the Department grounds in September of the previous year. It is quite positive now that this species is widely and generally distributed in Maryland and Virginia within a few miles of Washington, and to be found here almost wherever cucurbits grow. Since the first capture of this species in 1897 it has been found on cucurbits wherever sought for.

July 16 it was observed in abundance at Marshall Hall, more individuals of this species being seen than of *A. tristis*. It was apparently more abundant than the latter species, but this was probably not the case, as the latter, although nearly always to be found at the same time with it, is less active than *armigera* and not usually seen in the heat of the day. The greater activity of *armigera* was quite noticeable on this day, numerous individuals being seen in flight and freely exposed on the upper surface of the leaves, while *tristis*, when seen at all, was usually on the edge of a leaf concealed beneath the leaves or under débris in the immediate vicinity of cucurbit plants. The greater abundance of *tristis* as a whole in localities inhabited by both, the writer believes, may be accounted for, partially at least, by its darker color and less active diurnal habits. *Armigera* is particularly conspicuous when flying, as the upper surface of the abdomen exclusive of the connexivum or sides is bright orange, and this gives the principal coloring to the insect itself when in flight.

The dorsal surface of the abdomen of *tristis* is black, but occasionally this part is colored, as one individual captured shows a bright red interior.

July 29 nymphs of this species were found on cucumber at Cabin John, Md., as also on cantaloupe, but were rare on both plants. No squash grew in the vicinity.

This squash bug was never received through correspondence till August 3, 1898, when Mr. Henry J. Gerling sent specimens from St. Charles, Mo., with the accompanying information that they travel along the cucurbit vines, "taking an inactive position on either leaves or vines for some time." They were not detected in the act of feeding, as I

presume that our correspondent was not aware of the fact that they obtain their food by suction.

It is now fairly certain that this species has practically the same food habits as *tristis*. Where squash was available the insects were very rarely to be seen on melons or cucumbers. Such were the conditions at Marshall Hall and in Washington.

DESCRIPTION AND DISTRIBUTION.

This species was described by Thomas Say in 1825 (Proc. Ac. Nat. Sci. Phila., vol. IV, p. 319, Lec. ed., p. 244), but nothing concerning its biology has been published, so far as can be learned, prior to a short preliminary note by the writer, entitled "A new squash bug," which appeared in the September (1898) number of the Canadian Entomologist (vol. XXX, pp. 239–240).

The mature bug is of nearly the same size as *Anasa tristis*, from which species it may readily be distinguished by its broader prothorax with prominent angles, the reflexed connexivum or sides of the abdomen, which show each side of the hemelytra four prominent white marks, and its unispinose femora. This spine is borne by each leg near its apex. The surface above is brown, and the legs and first joint of the antennæ are whitish, spotted and irrorated with black. The terminal antennal joint is light-yellowish, as is also the articulation of the first joint with the second and the second with the third. In front of each eye, just behind the insertion of the antenna, is an acute porrect spine or horn. The adult is illustrated by figure 6, *a*.

The full-grown bug when first transformed is yellowish-cream color, the eyes showing brownish-red and the last antennal joint bright sanguineous. In a few minutes, however, the normal markings appear, the insect itself growing perceptibly darker as it is watched.

Say's specimens were from Missouri and there is a series in the National Museum from western Iowa and Florida. The species is essentially a southern one and evidently Lower Austral and perhaps Tropical, although some of the localities mentioned are Upper Austral. From the fact that the species is so well adapted to the climate of the District it seems probable that it is not a recent introduction from the South, but has been established here for many years. I fail to find mention of the occurrence of this species in Central America. It is not included in Biologia Centrali-Americana with *A. tristis*, but it doubtless occurs there, as we have in the National Museum collection a specimen from Port of Spain, Trinidad.

In the collection of Mr. Heidemann are three specimens of a species that at first glance would readily be mistaken for *armigera*. They are from the District of Columbia and Glen Echo, Md., and are labeled *Anasa repitata* Uhler MS. The most observable difference between this species and *armigera* is the absence of the porrect spines or horns on

the head. Its habits are unknown, but it doubtless also lives on cucurbits.

Still another species is likely to be mistaken for it. This is *Archimerus calcarator* Fab. It is a little larger than *Anasa armigera*, but from that species it may at once be known by its much thickened and multispinose femora.

THE EGG.

The egg closely resembles that of *A. tristis*, so nearly in fact that it is difficult to distinguish them otherwise than by color. It is beautiful, bright, shining coppery, lighter and with a less bronzy appearance than in *tristis*. It is also just perceptibly narrower at each end as viewed from below. Length, 1.50 to 1.60^{mm}; width, 1.15^{mm}.

The egg is shown at *b* and *bb*, much enlarged, and the reticulation of the surface is indicated by a much enlarged section at *c*.

NYMPHS.

Throughout the five stages of the nymph, *armigera* is so different from *tristis* that there is no danger of anyone mistaking one for the other. This applies to color, structure, and form about equally. The following most observable differences may be briefly indicated in tabular form for convenience.

NYMPHS COMPARED.

Armigera.	*Tristis.*
First stage.	
White, with red eyes, antennæ and red-banded legs and abdomen. Antennæ longer than body, penultimate joint widest.	Black, with green abdomen. Antennæ shorter than body, joints subequal. Legs nearly uniform black.
Second stage.	
Much like first stage; penultimate antennal joint still wider. Legs banded with brown.	Much as in first stage, abdomen gray, thorax lighter.
Third stage.	
Three segments of thorax scale-like, prolonged posteriorly, and overlapping; sides reflexed, strongly dentate and denticulate. Connexivum also strongly dentate.	Three segments of thorax not produced, reflexed, or dentate. Connexivum feebly subdenticulate or subspinose.
Fourth stage.	
As above, the thorax becoming wider and the reflection and denticulation more pronounced.	Pronotum feebly overlapping. Meso- and metanotum produced.
Fifth stage.	
Thorax produced at sides and otherwise much as in adult. Body variegated with brown and yellow. Legs with round black dots. Spines of head appear.	Thorax not produced. Body colors gray, dotted with black. Legs black at first, becoming spotted before last molt.

STAGES OF NYMPH DESCRIBED.

First stage (fig. 6, *d*).—Immediately after hatching, the nymph is clear white with the bands on the legs yellow, the antennæ, eyes, and the spots on the body red. In a few minutes, however, these parts begin to take on darker shades. A similar condition is observable also immediately following the shedding of the other nymph skins.

Just before the first molt the body is proportionately more rounded and robust than in the adult, and the appendages, including the head, are more prominent. The general color is clear white. The antennæ are a little longer than the body and considerably flattened, the penultimate joint particularly so. They are finely hairy, very dark red in color, and narrowly white at the sutures. The head is large, hexagonal, white, and the eyes are red. The body is white, widest about the middle of the abdomen, the wing-pads infuscated, and the abdomen marked with red, as shown in the dark shading in the illustration. The legs are white and ornamented with infuscate bands in the manner indicated in the figure, which sufficiently illustrates this stage as to render further description unnecessary. Length, about 2mm.

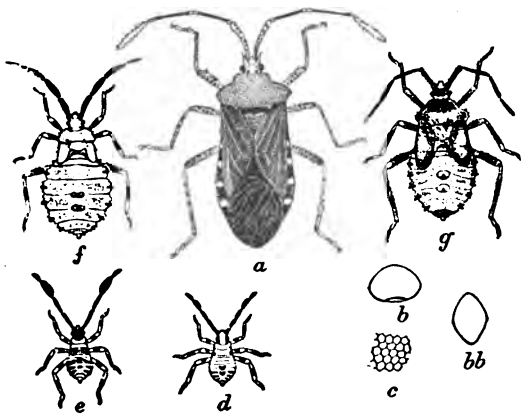


FIG. 6.—*Anasa armigera: a*, mature form; *b*, egg in profile, from side; *bb*, same, from above; *c*, sculpture of egg; *d*, newly hatched nymph; *e*, nymph after first molt; *f*, nymph, fourth stage; *g*, nymph, fifth stage.—*a*, twice natural size; *d*, *e*, *f*, *g*, nearly the same; *b*, *bb*, more enlarged; *c*, greatly magnified (original).

Second stage (fig. 6, *e*).—This stage very closely resembles the first. The antennæ, particularly the penultimate joint, become still more prominent and the head grows darker in color. The legs are banded with brown. Length, about 3mm.

Third stage.—The third stage differs from the second principally in the larger size of the body, which has assumed a pyriform shape, the darker color of the body and bands on the legs, and in the greater prominence of the tubercles at the sides of the body. The three thoracic segments are also more prominent, prolonged posteriorly, and overlapping at the sides. Its sides are reflexed, strongly dentate and denticulate. Connexivum also strongly dentate. Length, about 5mm. This stage is not illustrated.

Fourth stage (fig. 6, *f*).—With this stage, as in *tristis*, the wing-pads become evident, the thorax widens, the abdomen increases in girth, and the third joint of the antennæ decreases in width. The reflexion and denticulation is still more pronounced. Length, about 7mm.

Fifth stage (fig. 6, *g*).—In the fifth or last stage this species more closely resembles the mature form than is the case with *tristis*. This

effect is produced by the prominent angle of the prothorax and the similar markings of the legs. In addition to the increased length of the wing-pads and other observable characters, shown in the illustration, the spines in front of the head which have now made their appearance are noticeable. The central portion of the abdominal tubercles are yellow, and yellow alternates with black on the lateral tubercles of the abdomen. The entire body, including the ventral surface, is darker in color. The last antennal joint is black, at least in its posterior moiety, the tip being yellow. Length, about 9mm.

LIFE HISTORY.

The eggs of this species are deposited in much the same manner as are those of the common squash bug, the young making their escape in the same way. Thus far, however, egg masses that have been found are all smaller, numbering not more than about 20, as compared with 30 or 40 which are often observed in *tristis*.

July 30, in examining watermelons for evidence of insect attack, two masses of eggs of this squash bug were found on different melons, deposited on the under side near the ground.

Often this species is to be found with its congener, living in different stages in apparent harmony. Colonization is rather less obvious than in the case of *tristis*.

A pair of adults was obtained July 14. On the following day they were observed mated and next day 10 eggs were deposited.

The precise period of the egg from deposition to hatching was not noted. It was presumably about eight days, however.

The different stages of the nymph of the horned squash bug, with the exception of the first and fifth, occupied five days between each molt, as observed during the hottest weather, represented by an average of about 85° F.

The first molt occurred two days after hatching; the fifth stage occupied six and eight days in different lots. These periods, including the egg, may be tabulated as follows:

Stage.	Date.	Periods.
Egg	Not observed	Eight days (estimated).
First nymph	July 28 to 30	Two days.
	July 29 to 31	
Second nymph	July 30 to Aug. 4	Five days.
Third nymph	Aug. 3 to 8	Five days.
	Aug. 4 to 9	
	Aug. 9 to 16	Seven days.
Fourth nymph	Aug. 9 to 14	Five days.
	Aug. 16 to 21	
Fifth nymph	Aug. 15 to 22	Seven days.
	Aug. 21 to 28	
	Aug. 3 to 11	Eight days.

The minimum period of the entire life cycle was thus thirty-two days. In another experiment in which a lot of adults were placed in a large rearing cage together so as to be under more natural conditions than

was the case where each stage was observed separately, this species passed its life cycle in the same time, the period being from the date of the beginning of the experiment to the finding of the first newly transformed bug, thirty-two days, August 2 to September 3.

The finding of eggs during the last days of September as observed in 1897 would certainly seem to indicate a tendency toward the production of a second brood. In 1898 the adults of the hibernated generation were nearly all dead in the field by the 2nd of August, but a few individuals remained some days longer in our rearing cages after this time. There was practically no overlapping of generations and there is no evidence to show more than a single generation annually since the eggs laid in September could not, in the writer's opinion, by any possibility have produced mature insects that year, for the lack of a food supply if for no other reason. Disappearance for hibernation began in September, and soon after the first of October the species had practically disappeared. One individual was found with its back incrusted with earth under a pumpkin in November.

NATURAL ENEMIES.

Undoubtedly this insect is exposed to the same enemies as the common squash bug. One individual of the adult captured in 1897 bore eggs of a Tachinid and another contained a hole through which the adult fly, probably *Trichopoda pennipes* Fab., the well-known enemy of the adult of *Anasa tristis* had made its escape.

REMEDIES.

In addition to the remedial measures specified as of value against the common squash bug and which will undoubtedly prove equally successful against the present species, it is probable that we may be able to control it at least in the latitude of the District of Columbia by taking advantage of its late presence in the field. This may be accomplished by setting out a few late cucurbits as a trap crop. After the old vines have been destroyed the bugs will congregate on the later plants and here can be more successfully dealt with. A good way would be to distribute these trap plants about the garden patches and then set fire to them when the bugs have congregated upon them in sufficient numbers. This could readily be done by throwing upon the plants dry straw or similar material and adding a little kerosene.

SOME OBSERVATIONS IN THE LIFE HISTORY OF THE SQUASH-VINE BORER.

(*Melittia satyriniformis* Hbn.).

In the gathering of material that would illustrate the life history of the squash-vine borer a number of observations were made that may be of interest in connection with the illustrations which are here presented.

As no technical description of the egg appears to have been published, the notes which follow may properly begin with such description.

THE EGG AND OVIPOSITION.

Form oval, convex above, with a rather well-defined broad and more or less impressed disc (see fig. 7, *a*). Surface of attachment flattened to the object upon which the egg is deposited (see *b*). Color, dark, dull reddish brown. Surface finely reticulate, divided into minute areas which usually take the form of hexagons, as shown at *c*, but which are not infrequently pentagons, heptagons, and even octagons. Each area under a high power of the microscope is seen to be composed of many smaller areas or pits. Length, 1 to 1.12^{mm}; width, 0.76 to 0.90^{mm}.

A group of three eggs is illustrated as deposited, about one-third larger than natural size, at *c* of figure 8.

Eggs that were laid July 15 hatched on the 21st, or in six days. Those deposited July 16 hatched July 22, beginning about 9 a. m., in a little less than six days.

The female from which these eggs were obtained was confined in a cool, dark room, except when in use as a model for the illustration which is presented in this article, and deposited during the short time that she was kept under observation 3 eggs July 15 and 54 the day following, the latter mostly just before noon, and this while in close confinement under unfavorable conditions. Prof. J. B. Smith, who has given the study of this species considerable attention in New Jersey, records as high as 212 eggs dissected from a single female. He also makes the statement that the larvæ appear in from twelve to fifteen days after the eggs are laid.

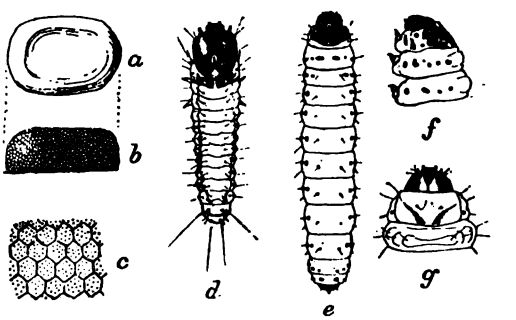


FIG. 7.—*Melittia satyriniformis: a*, egg as seen from above; *b*, same from the side showing sculpture; *c*, sculpture of egg greatly enlarged; *d*, newly-hatched larva; *e*, half-grown larva; *f*, head of same from side; *g*, head of mature larva from above; *a*, *b*, and *d*, much enlarged; *e*, *f*, and *g*, less enlarged (original).

THE LARVA.

In the summer of 1897 it was noticed that the larvæ of an apparently second species were also at work within the stems of squash. These were much smaller and more slender than those of what were known to be *Melittia satyriniformis*, but as they were not known to be different species, no effort was made to preserve specimens or to rear them at that time.

The following year the same larvæ were observed. Those who saw them believed them to be a distinct species, but the writer was extremely doubtful as to the possibility of two species being present on

cucurbit vines, as no other adult Sesiid has ever been found on cucurbits by those who have studied this class of insects. This opinion was strengthened by rearing at about the same time the young larvæ from the eggs. To verify the writer's belief in the matter, a number of young larvæ that appeared to be ready to molt were separated, and July 25 two molted, and upon the next molt the ordinary form of *satyriniformis* was obtained. The species was not carried through all its molts, as this would require close application, and press of other matters already under way did not permit the undertaking, but enough was learned to show that the larva differs greatly from the time it hatches from the egg until it is ready for pupation.

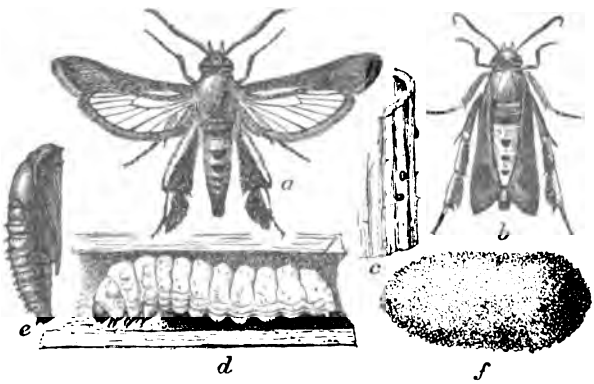


FIG. 8.—*Melittia satyriniformis*: *a*, male moth; *b*, female, with wings folded in natural position when at rest; *c*, eggs shown on bit of squash stem; *d*, full-grown larva, *in situ* in vine; *e*, pupa; *f*, pupal cell—all one-third larger than natural size (original).

Reference to Dr. S. H. Scudder's "Notes on *Melittia cucurbitæ* and a related species," published in Psyche (vol. IV. pp. 303, 304), in 1885—but as that writer states recorded in notes more than twenty-five years before that time—shows that he had these two forms of this vine borer as subjects for his descriptions and notes. On this head the late Dr. Kellicott wrote (Can. Ent., vol. XXIV, p. 209; Insect Life, vol. V, p. 82): "Among the smaller ones [larvæ] there was an abundance of that second form described by Dr. Scudder, in Psyche, vol. IV, p. 303. Some of these were isolated, and after a few days, they molted, giving the typical form. This seems to prove that there is but one species."

The accompanying illustrations show the great differences between the newly hatched larva, the half-grown larva, and the mature form.

The larva when first hatched is of the appearance shown in figure 7 at *d*. The head as with other newly hatched larvæ is much larger in proportion to the body than later on in its development; the body tapers toward the anal extremity, the thoracic shield is considerably different, and the entire surface is much more hairy than in later stages. The length is 1.8^{mm}; the width at the widest portion of the body, the first thoracic segment, is 0.66^{mm}, while the head measures 0.58^{mm} across.

The half-grown larva is described by Dr. Scudder in the article quoted, and this description need not be repeated in detail. The head is jet black and the dorsal surface of the first thoracic segment is nearly black, in both of which respects—as well as in the black anal process, which sometimes ends in a well-defined hook—it differs from the full-grown larva. Length, 13^{mm}; width, 2.5^{mm}.

A dorsal view of the half-grown larva is presented at *e*, fig. 7, *f* showing the head and thoracic segments in profile.

The full-grown larva, figured in profile within an opened squash stem at *d*, fig. 8, is also fully described in the paper quoted. The head, it will be noted (fig. 7, *g*), is ornamented with a median white space, being usually dark brown at the sides, and the first thoracic segment is marked dorsally by two curved oblique brown bands which converge posteriorly. The full length is 25^{mm}; width a little more than 6^{mm}.

THE COCOON AND CHRYSALIS.

After attaining maturity the larvæ desert the stems and enter the earth, burying themselves to the depth of one or two inches, and form their cocoons in which they transform to pupæ.

In its chrysalis case or cocoon the larva contracts to about 15^{mm}, the case itself being a little shorter than the larva before contraction, averaging about 22^{mm} in length by 7^{mm} or 8^{mm} in width. The cocoon, shown at *f*, fig. 8, is composed of silk and is stout of texture, though rather thin when divested of the outer coat of grains of sand or earth which adhere to it by means of some gummy secretion of the larva. When thus treated it is found to be nearly black in color, both within and without.

The pupa or chrysalis, shown in profile at *e* of figure 8, measures about five-eighths of an inch in length (16^{mm}). It is shining mahogany brown in color and its head is ornamented in front just above and between the eyes with a horn-like process. By means of this the pupa cuts its way out of one end of its cocoon, and by the aid of the abdominal hook-like spines forces itself to the surface of the earth before transforming to imago.

THE MOTH BRIEFLY DESCRIBED.

As a complement to the illustrations and the descriptions of the life stages of this insect the mature moth may be briefly described.

The male moth is illustrated at *a* of figure 8. It is a most beautiful creature, a member of the family Sesiidæ, otherwise known as clear-winged moths. Its fore-wings are opaque, lustrous, olive brown in color, with metallic green reflections, and the expanse is from less than an inch to nearly an inch and a half. The hind-wings, from which this family of moths derives its vernacular name, are clear and transparent and veined as shown in the figure. The abdomen is conspicuously marked with orange or red and black or bronze, and the hind legs

are fringed with long hairs, red or orange on the outer surface and black inside.

The female moth is illustrated in the figure at *b*, this representing the natural position when at rest.

SYNONYMY.

A few words of explanation are due in regard to the specific name *Melittia satyriniformis* used in the title head. This name was given by Huebner, who described the species in 1825. Three years afterwards Harris redescribed it as *Ægeria cucurbitæ* (New England Farmer, vol. VII, p. 33), and later Westwood gave the name *Trochilium ceto*, and as *Melittia ceto* it has for some reason been generally known in literature and collections up to a recent date. For a discussion of the synonymy and a full bibliography, see Mr. William Beutenmuller's paper (Journ. N. Y. Ent. Soc., vol. V, pp. 34, 35).

MANNER OF WORK OF LARVA.

Ordinarily the larva works in the woody parts of the stem, boring in both directions and appearing to prefer the portion near the roots. When many larvæ, however, occur in a single vine in such abundance as to exhaust their food supply, they eat outward toward the bases of the leaf stalks. In one vine that was examined July 23, 1898, nearly every leaf stalk had been eaten into at the base, but not entirely through except in a few cases. In these instances the larvæ, which were nearly all approaching maturity, had worked through the leaf stalk up to the leaf itself. The larvæ, practically throughout their entire existence, are perfectly capable of traveling from one vine to another, and in confinement were able to crawl up the sides of glass jars and to suspend themselves by means of their webs.

From what has already been stated, it is obvious that the younger larvæ are more often found within the leaf stalks, and the older larvæ within the main stem. While the larvæ confine their work to the stalks, injury is hardly noticeable, but as they grow older and penetrate to the main stems near the roots damage becomes more apparent. One day the plant will look thrifty, and unless one examines the stem very closely for the excrement of the larvæ, infestation would readily escape notice, but within the short space of a single day all this may be found changed. The leaves wilt and die down and examination will now show a place where the stem has been cut off so closely from the roots that the drying effect of the sun has completed the work. A light pull at the stem and it will part at this point.

NUMBER OF GENERATIONS.

The question of the number of generations produced annually was practically solved by the late Dr. Kellicott in central Ohio, and Mr. J. D. V. Walker on Long Island. The finding of larvæ still at work in

the stems as late as the middle of October in Columbus, Ohio, and still later in the District of Columbia, would suggest this and careful observations show that the species is partially double-brooded in this latitude, practically single-brooded on Long Island and northward, and fully and normally two-brooded in the Gulf States. Imagos were reared many years ago by John Abbott in Georgia, August 11, from larvæ which spun up July 16; by Kellicott at Columbus, August 20 and afterward; and indications are that a moiety, probably less than half, normally develop the first year in the latitude of Columbus, while the remainder winter over as larvæ and complete transformation the following year. In New Jersey, according to Dr. J. B. Smith, the species in exceptional cases completes its transformations "late in August or in September."

From larvæ obtained in 1898 and kept feeding in our rearing jars at this office a moth was obtained August 25. A pupa from which the moth had already issued was also found the same day under a cover placed over a borer-infested squash plant on the grounds of the Department. Larvæ, which undoubtedly belong to the second brood, are always to be found in the vines in the District during October, and some are still to be seen in November as late as the second week, as happened the past year. The plants, cymlings and pumpkins, upon which these larvæ were observed were all planted in July, one lot in which a larva not quite full grown was found October 16, having been planted July 16. Moths of the first generation were observed that day and as late as July 22.

TIME OF APPEARANCE OF THE MOTH; NUMBER OF GENERATIONS.

For lack of opportunity of frequent observation the earliest appearance of the moths in the District of Columbia and vicinity has not yet been ascertained. At the times when moths have been sought for in June and early July they have hitherto escaped observation. Yet the larvæ have been found full grown (25^{mm} long) in squash stems on our experimental plat as early as July 16. This happened in 1897, a year in which the season was estimated to be at least two weeks late; and from this it appears probable that the larvæ mature here in normal seasons as early perhaps as the first week of July. The seed in this case was planted June 5. Larvæ are to be found in the latitude of the District of Columbia from some time in June until as late as the second week in November, provided that food be obtainable for them, and this even though several frosts may have occurred and the plants be dead.

It is evident from the facts observed that there are three lots of moths occurring during the year, each lot following or even being "overlapped" by the preceding one. The first lot appears late in May or early in June and July, and probably is the offspring of the larvæ of the first brood, which have wintered over instead of issuing as imagos the first year. The second lot appears later in July and early in

August, and is probably the product of the second brood of larvæ produced during the previous year. The third lot, which forms the normal second brood, appears late in August and probably later. This peculiarity in reproduction and the subsequent appearance of the parent moths is of course, somewhat hypothetical and evidently a survival of the times when this species lived in the Tropics, where breeding was almost continuous except during rainy seasons. The instinct of the insects is still to appear early and remain late, provided the appropriate plants are available for their food.

ECONOMIC STATUS.

In the District of Columbia and in nearby localities in Maryland the squash-vine borer has been during the past two years the species most to be feared as an enemy to the culture of squashes. Of its status in other regions Dr. Smith, writing in 1891, says that it is "the most dangerous enemy to squash culture in New Jersey." In New England, according to another writer, it is "the most obstinate enemy to this crop in the settled sections." In other localities this species has to yield the first place as a cucurbit pest to the striped cucumber beetle, particularly where cucumbers are the staple crop; and in others, where melons are the chief product, the melon louse is the principal pest.

PREVENTIVES AND REMEDIES.

Ordinary insecticides are of no value against this insect when once it has entered the vines, and repellents are also practically useless. The measures that have been found of greatest value are, in brief: Not to plant in or near infested ground; to plant early varieties for the protection of late squashes; to harrow infested fields late in fall and plow deeply in spring, or reverse the process, to prevent the moths from issuing; to encourage the growth of secondary roots by covering the vines at the joints with earth; to destroy dead vines and old plants as soon as the crop is made; to keep the plants in vigorous condition, free from other insects and diseases; to cut out such borers as may succeed in entering the vines, which they will sometimes do in spite of the observance of precautionary measures; and to capture the moths early in the morning or toward dusk when they are less active than in the heat of the day. The employment of all the methods of control mentioned is not necessary, but if the grower would make certain of securing a good crop in localities where this and other enemies of the squash occur in their most troublesome numbers it will be wise to observe most of these precautions, and if possible it will be well to secure the cooperation of neighboring farmers in their observance.

NOTES ON THE PICKLE WORM AND MELON CATERPILLAR.

THE PICKLE WORM.

(*Margaronia nitidalis* Cram.)

OBSERVATIONS IN 1897.

September 4, 1897, it was noticed at Cabin John, Md., that such cymlings as had escaped the ravages of the vine borer, *Melittia satyriniformis*, and did not yet bear developed fruit, were attacked by the pickle worm boring holes into them from without. One cymling contained nearly a dozen holes, and one of the larvæ emerged from the largest hole, which appeared to be the only one that was then occupied, and started to make another. Afterwards it returned through the large hole, but finally perished, evidently of a bacterial disease. Another, that was nearly mature, refused to emerge from the interior of the cymling which it inhabited. When last observed, September 9, it was in perfect condition, but when sought for on the 10th it had entirely disappeared, evidently dying of the same disease that had attacked the first specimen mentioned.

Holes were also noticed in muskmelons in the same garden, and September 11 a larva was cut from one and kept until the 16th, feeding on bits of cymling. On the morning of this date it left the piece upon which it was feeding and in the afternoon began to spin up. On the following day it completed a very fragile cocoon and remained motionless, hanging downward. The cocoon was formed that night.

An infested cantaloupe brought to the office from Ballston, Va., September 15, and confined like the other, showed the work of this larva, which cast out large quantities of frass and excremental fluid for three days. On the 20th, however, it had ceased, and when the fruit was cut open nothing could be found. It had evidently fallen a prey to the disease which had killed the other, as there was no possibility of escape.

A larva was taken upon a leaf of cymling on the experimental plat of the Department September 30.

October 1 and 2 the work of this species was observed on the office plat of cymling squashes, in buds, in ovaries, and in immature and nearly ripened fruit. Larvæ were found at work in all of these parts of the plants, and openings quite different from those of the vine borer, were also found in the stems; and, although the larvæ were not observed, it is more than probable that all of them were due to the work of the caterpillar of this species, as they had plainly been made by a caterpillar boring into them from without.

A larva taken from a cymling October 1 began to spin up its cocoon the day following, and transformed to a chrysalis on the 5th. On the 25th it issued as an adult, having remained three or four days in its cocoon before transforming and twenty days as a chrysalis.

OBSERVATIONS IN 1898.

For some reason *Margaronia nitidalis* was not to be found in the vicinity of the District of Columbia during 1898, in spite of frequent and careful search. It seems not improbable that the species was unable to survive the rigor of the winter season of 1897–8 or at least succumbed to some atmospheric condition unfavorable to its hibernation. Should this hypothesis prove correct it will be interesting to learn how long the species will be in establishing itself by migration from farther south. Specimens, however, were received from the South and under such circumstances as to show that work is needed upon the earlier stages of our two cucurbit-feeding Margaronias.

Mr. Charles Deckner, Atlanta, Ga., wrote that this species, specimens of which he sent, attacks the crop in his locality from the middle of July to the first of August, continuing its destructive work until frost.

A larva received from Mr. Deckner spun its cocoon August 16 and transformed to pupa the same night. It was found as imago early on the morning of the 26th, from its appearance having issued the previous night. This would give the pupa period as nine days, weather very hot, average about 85° indoors where this specimen was kept.

August 22, 1898, Mr. James H. Hevey, of Ingomar, Miss., sent leaves of squash plant on which were two larvæ so conspicuously spotted as not to be recognized as belonging to either species of Margaronia. One was just hatched, and the other was perhaps half grown, being about half an inch long at the time when received. A larva of the same species was sent in on the same day by Mr. Deckner, also found on squash. When first received these larvæ fed upon the leaves. A few days later they could not be found, but after careful search were discovered in the leaf stalks, into which they had bored. This is evidently their normal habit, as after they have once crawled into a stalk they cease to feed upon the leaves. In the confinement of a rearing jar they crawl through the open ends of the leaf stalks to the narrow portion nearest the leaf, and after hollowing this out they force their way up into the larger ribs of the leaf.

During the closing of the office September 4 and 5 these larvæ shed their spotted skin, appearing dull brownish green, with a dorsal row of shining round spaces of the same color, from which it was inferred that they belonged to this species; but as we failed to rear them to the adult condition this could not be ascertained with certainty.

Messrs. Deckner and Hevey both sent more material, but, unfortunately, owing to bad weather, none of the larvæ received were in condition for breeding.

THE MELON CATERPILLAR.

(*Margaronia hyalinata* Linn.)

August 13, 1898, Mr. Charles Deckner, of Atlanta, Ga., sent specimens of the larvæ of this species, mostly full grown, in cucumbers and melons; also a specimen of the moth. The moth was taken on the cucumber

vine. He described the moths as very shy and difficult of capture. They remain in hiding all day and appear only after dark, when, by aid of a lantern or other light, they may be seen darting among the vines.

The species was not so destructive this year, owing, it was believed, to the excessively damp weather in that locality. Our correspondent was of opinion that these larvæ do not feed on the foliage of melons or cucumbers, but that when fruit is scarce they frequently attack the tip of the vines where these are tender. In this respect this species resembles *nitidalis*, which, as we have previously observed, will attack buds and ovaries in the event of scarcity of fruit. They leave the vines, our correspondent further states, and go into the fruit whenever they have the opportunity. The vines also are attacked, the larvæ boring into them a few inches from the tip and working their way inside the vine to the extreme end.

Our correspondent expressed the opinion that there may be some chance of attracting the moths to lights.

September 3 Mr. Deckner again sent specimens of the adult moth, with the information that his cucumber patch was at that time swarming with them. During the rainy season they appeared to be unable to conceal themselves and were easily dislodged. They were moving about then in large numbers. All of the specimens reared from larvæ sent by Mr. Deckner proved to be *nitidalis*, and all those kept by him and reared at Atlanta were the same species, a matter which greatly puzzled our correspondent as well as the writer.

What was believed to be the immature larva of this insect was received in precisely the same manner and at the same time as was that of the pickle worm. It was found by Messrs. Deckner and Hevey on the foliage of squash, and, as with the immature pickle worm, was not identified nor reared. The supposed immature larva was striped very much like that of the greenhouse leaf-tyer, *Phlyctænia ferrugalis*. This striate appearance was observable in the larvæ while quite young and until after they had attained a length of an inch.

Until the past year the writer had not been aware of the presence of this species in the vicinity of the District of Columbia. During the fall the adult was taken on two occasions, late in September and in the early part of October, by Mr. F. C. Pratt, captures being made in the city of Washington at light.

The known distribution of this moth includes Cuba and Jamaica, and as it is much more abundant in the most Southern States it is probable that it is of tropical origin. Our divisional records of localities include the Atlantic and Gulf States from the District of Columbia southward and westward to and including Texas. It has also been reported from Ames, Ill., Manhattan, Kans., Columbus, Ohio, Agricultural College, Mich., Buffalo, N. Y., and Hamilton, Canada. The larva has never been detected in the District of Columbia, and some doubt

attaches to the permanency of the species in this latitude. Injuries are much more pronounced in the South, and are probably not appreciable, if they occur at all, in the more northern localities mentioned.

REMEDIES.

There is little doubt that the first-hatching larvæ feed for some time upon the foliage or upon the outside of the stems before entering them or the fruit. This renders them vulnerable to insecticides, and of these nothing is better than Paris green, which has already been advised against these two species. After the larvæ have entered the stalks or the fruit they can not be reached with poisons.

LEAF-FOOTED PLANT-BUGS WHICH ATTACK CUCURBITS.

THE NORTHERN LEAF-FOOTED PLANT-BUG.

(*Leptoglossus oppositus* Say)

RECENT OCCURRENCE AND INJURY.

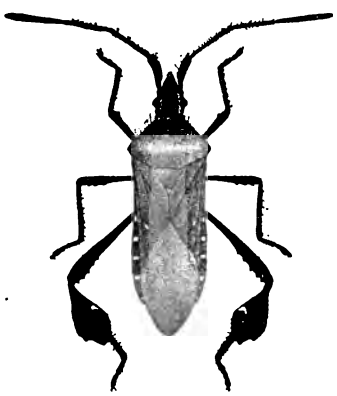


FIG. 9.—*Leptoglossus oppositus*—twice natural size (original).

This plant-bug, which is a near relative of *Leptoglossus phyllopus*, the injurious leaf-footed plant-bug of the orange and other tropical fruits, has recently come under observation in such manner as to stamp it as an enemy to the growth of cucurbits, although not one of prime importance.

September 11, 1897, adults of this bug were noticed by the writer on canteloupes at Cabin John, Md., but no special significance was attached to the occurrence. Two days later, however, on the 13th, Mr. W. D. Hughes, of Keedysville, Md., sent us a large series of specimens, with the statement that the insect was very destructive on melon vines in his vicinity during the season.

On the 16th of the same month two colonies of this bug were found on cucumber vines near Tennallytown, D. C. It was present at this time in all stages except the egg. Later, on the 29th of September, larvæ and nymphs were observed in the same locality on watermelon vines.

August 25, 1898, a colony of nymphs, mostly of the second stage, was found on squash growing on the experimental plat of this Department. The following week another colony was observed on these grounds, and during the second week of September the fourth stage of the nymphs was observed. By the 14th, or the beginning of the third week, most of the nymphs were in the fourth stage; one, however, transformed to the fifth stage on this date. The same day a colony was discovered at Tennallytown, D. C., in the same place where the species had been observed the previous year.

PUBLISHED AND DIVISIONAL RECORDS.

The first mention which I find of this species in literature is that of Dr. C. H. Hedges and the late Dr. Lintner, the former of whom mentions its occurrence in large clusters of twenty or thirty individuals upon grape and corn stalk at Charlottesville, Va., September 15, 1886 (Country Gent., Oct. 7, 1886, p. 753). Dr. Lintner states that the species was supposed to have carnivorous habits. Mr. W. H. Ashmead includes it in his enumeration of the enemies of the cotton plant (Insect Life, vol. VII, p. 320).

In addition to the correspondence previously mentioned we have received complaints of injury from Messrs. A. H. Mundt, Fairbury, Ill., and Charles L. Snyder, Oakton, Va. The former sent eggs and young nymphs found on a hedge plant during June, 1894. From the latter, material was received that had been taken on Russian apricot trees and which were puncturing the fruit and sucking the juice, the fruit presenting a withered appearance and bearing scars and marks of injury on the skin. Nymphs of this species of the earlier stages were found at this time (July, 1895) in considerable numbers on the leaves and fruit of the same tree.

HABITS OF THE SPECIES.

The natural wild food plant of this species remains to be discovered. Evidently it is a general feeder, and its observed feeding habits indicate a probable wide range of food plants.

Aside from their omnivorousness, these creatures agree in their habits rather closely with the squash bugs, their time of first appearance being later than that of either of the others. The nymphs have the same habit of collecting during the heat of the day under, or on the edges of leaves of their food plant which have become curled and dried, perhaps from their own work upon the stems, all stages being found sometimes rather closely crowded together in single colonies. In shady places and on cloudy days, and probably also at dusk, the nymphs scatter about somewhat upon the plants in the immediate vicinity of their permanent resting place, but they appear to adopt a particular leaf as a permanent abiding place and, even though disturbed, return to that leaf day by day. These insects are quite rapid in their movements, and when disturbed soon scatter in all directions, to return only when the apparent danger no longer threatens.

DESCRIPTION AND DISTRIBUTION.

This is a large chocolate-brown heteropterous bug of the family Coreidæ, somewhat resembling the squash bugs, to which it is nearly related, but from which it may readily be distinguished by its more slender form, acutely pointed head, and longer haustellum, antennæ, and legs, but more particularly by the peculiar leaf-like expansion of the hind legs (see fig. 9). The hind femora are much thickened and

bear two rows of strong, thorn-like teeth on the inner surface and several less prominent teeth and tubercles on the outer side. The hind tibiæ are strongly dilated (sometimes considerably more than in the specimen figured) near the middle into flat expansions or plates and bear two prominent, and usually one and sometimes two less prominent, teeth on the lateral surface and several minute teeth or serrations on the medial surface. The antennæ are lighter than the head, growing rather gradually lighter toward the apices, where they are yellowish-red. The apex of the scutellum is marked with a white point where the hemelytra meet, and each hemelytron is dotted near the middle and behind the scutellar spot with a similar whitish submedial point. The inner dilated surface of the tibiæ is also marked just in front of the middle with a similar spot, and the connexivum or reflexed sides of the abdomen shows each side of the hemelytra a row of three or four similar small white marks. Length of body, 18 to 21^{mm}; width across thorax, 5 to 6^{mm}.

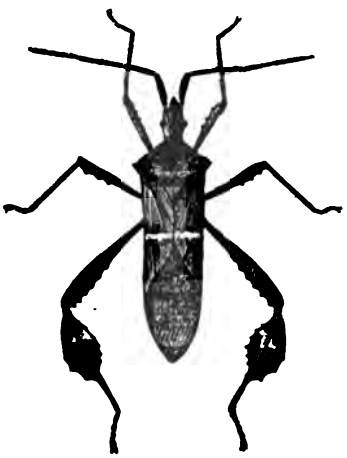


FIG. 10.—*Leptoglossus phyllopus*, twice natural size (after Hubbard).

The sexes may be determined by the genital structure, which resembles that of Anasa. The males are more slender than the other sex.

This species may at once be separated from any other similar insect occurring on cucurbits as far north as Maryland and Virginia by the large teeth of the inflated tibiæ. *L. corculus*, which occurs in the same region and southward, has the tibiæ less dilated and without large teeth. The southern *L. phyllopus* has somewhat wider expansions of the tibiæ, and the hemelytra marked just above the middle by a conspicuous transverse white band broken at its center, which marking takes the place of the two dots on the hemelytra of *oppositus*. *L. phyllopus* is also a little smaller and slenderer, and has the lateral angles of the prothorax more acutely pointed.

This plant-bug was described by Thomas Say in his "Descriptions of new species of Heteropterous Hemiptera of North America" in 1831 (Lec. ed., p. 327) as *Anisoscelis oppositus*, from Indiana. Stål records its occurrence in Georgia and Texas, Uhler also in Indian Territory, North Carolina, Maryland, and Kentucky. It occurs as well in the District of Columbia, as previously mentioned, and in Virginia.

THE BANDED LEAF-FOOTED PLANT-BUG.

(*Loptoglossus phyllopus* Linn.)

During August, 1898, this species came under notice as an enemy to cucurbits through correspondence with Messrs. W. H. McLeod & Sons, Seabrook, S. C. August 15, specimens of the insect, which is known

locally as the "blood sucker," were received with the information that they injure potato tops in the spring and devour as well fruits of all kinds, and especially watermelon by sucking the stems close to the melon. Sometimes half a dozen of these bugs may be seen at work on a single stem. They were described as a general nuisance, but had never been observed in such great numbers in previous years as to do the serious damage noticed in 1898. These bugs were also stated to attack the pecans, which were injured by lepidopterous larvæ, and they were believed to be at least responsible for a portion of the damage done to these trees. Attack was first noticed about the first of May, when a great many of the bugs were observed in the tops of the trees.

May 22, 1897, we received from Mr. Thomas H. Maxwell, Keller, Ga., specimens of this bug, with the statement in an accompanying letter that the species injured young pear trees, stinging the fruit.

June 23, 1898, Mr. J. B. Rudulph, statistical correspondent of this Department, sent specimens from Pleasant Hill, Ala., with the statement that the species had been injurious that year and the two preceding years. There seemed to be thousands of them. On nearly every ripening peach there were from two to four individuals. The bugs were first noticed the 20th of May. Our correspondent was satisfied that all of his early peaches had been cut short by the work of this insect.

This plant-bug, which is common and injurious to various plants throughout the South, has been reported by Mr. A. L. Quaintance (Fla. Agr. Exp. Sta. Bul. 34, p. 300) as an enemy of melons in Florida. He states that frequently it "is the cause of serious trouble, by puncturing the stems of plants and sucking their sap, causing them to wilt, and, not unfrequently, bringing about their death." The same writer records attack by this species to strawberry, the fruit and tender shoots of which it injures. Nymphs were also observed on the Irish potato, and this may hence be considered a probable food plant (L. c., Bul. 42, pp. 581, 582).

This species first came into prominence as a pest through its injuries to the orange in the South, and an account of it was given, together with an illustration which is here reproduced (fig. 10), by the late H. G. Hubbard in his bulletin entitled "Insects affecting the orange," published by this Department in 1885 (pp. 168, 169). As with the previous species the dilatation of the hind tibiæ exhibits considerable variation, many individuals showing more dilated tibiæ than those figured. Oranges are attacked while in fruit, and injury is also reported to the strawberry, peach, plum, currant, eggplant, cotton bolls, and "even potatoes."

The normal food plant of this bug is the yellow thistle (*Carduus spinosissimus*), and it is recommended that thistles and like plants which might serve as breeding places for this species should be cut down and destroyed where they are found growing in the vicinity of truck or garden crops, or orchards.

The most obvious differences between this species and *oppositus* have been pointed out in the consideration of the latter.

The distribution of this plant-bug comprises the entire Gulf region, where it is very abundant, and includes most of the neighboring States if we may judge by its recorded distribution in Arizona, Missouri, South Carolina, and Indian Territory.

REMEDIES.

Both of these plant-bugs can be controlled by hand-picking or by capturing them in inverted umbrellas, bags, or specially prepared nets saturated with kerosene, the best time for their capture being in the early morning or late in the evening, as they are apt to be active, taking wing readily, in the heat of the day.

A certain measure of relief should be obtained by the free use of kerosene emulsion, which will at least kill the younger nymphs.

The Southern or banded leaf-footed plant-bug could be captured by the use of thistles planted about the infested gardens, fields or orchards, as these plants would attract the insects where they could be more readily dealt with than if scattered. The thistles should be cut down before the seeds mature, and the heads at least should be destroyed by burning, as a single large patch of thistles has been known to infect a wide area. It is possible that immunity from attack might be secured by the destruction of all the thistles within a large area in the neighborhood of groves of oranges or gardens, and that no further measures would be needful for the suppression of the pest than constant watchfulness that no thistles be allowed to grow in the vicinity.

NOTES ON THE STRIPED CUCUMBER BEETLE.

(*Diabrotica vittata* Fab.)

THE EGG AND OVIPOSITION.

In Circular No. 31, on our common striped cucumber beetle, attention was called to the absence of any published observations on the egg and oviposition. Of the normal method of the latter nothing has been positively learned, but eggs were obtained from which the following description and accompanying illustration were made:

FIG. 11.—Egg of *Diabrotica vittata* at left, much enlarged, sculpture more enlarged at right (original).

The egg.—The egg, as would naturally be surmised, resembles that of other congeneric species which have already been described. It is smaller and more slender proportionately than *D. 12-punctata*, *longicornis*, and *soror*, measuring but 0.60 to 0.62^{mm} in length by 0.32 to 0.36^{mm} in width, being, therefore, only a little less than twice as long as wide. Its color is bright-lemon yellow, but this may vary somewhat with age as well as individually, as some are under observation that are orange color. The surface is finely sculptured, the hexagonal pits arranged as in *longicornis* as figured by Dr. Forbes (12th Rept. St. Ent. Ills. for 1882, p. 18). There appear to be by estimate about 35 pits in the entire length of the egg.

METHODS OF CONTROL.

The methods of dealing with this insect that have been employed with greatest success in the past have been considered in Circular No. 31, second series, of this Division. A considerable correspondence during the year (1898) adds somewhat to our knowledge of remedial measures. With an insect so difficult to control, the testimony of our correspondents as to the efficacy of the remedies described in the circular, as well as of others employed by them, is worth recording.

DETERRENTS.

Sulphur.—May 13, Mr. Charles N. Ainslie wrote that this species is extremely numerous and injurious at Rochester, Minn., sometimes skeletonizing the leaves of mature plants (cucurbits). He states that he has successfully used for years the remedy of dusting the plants while the dew is on them with flowers of sulphur. "This adheres to the leaves, both above and below, if properly applied, and is very distasteful to the insects. I have never known this remedy to fail."

Plaster.—Mr. H. L. Frost writes that the market gardeners in the vicinity of Boston, Mass., find no trouble in protecting their plants by the simple use of plaster three or four times during the season.

Ashes and road dust.—Mr. M. J. Furlong, Fisher, Minn., writing August 14, stated that the farmers of his vicinity have no difficulty in keeping this insect in check by dusting the plants with sifted ashes or road dust while the dew is on them or after a rain. Ashes are preferred.

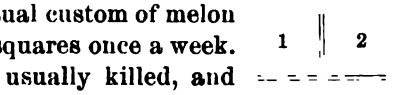
Mr. George Caswell, Dayton, Ohio, writes June 17, that during an active experience of about forty years he has found, all things considered, that there is nothing that will equal dry wood ashes sprinkled on the vines when damp for ridding cucurbits of insects of all kinds. A sharp lookout, he adds, is necessary, however, to prevent the insect from getting the best of the plants as soon as they appear above ground.

INSECTICIDES, ETC.

Mr. J. C. Andrus wrote May 15, that this species is injurious in Manchester, Scott County, Ill., and destructive on all species of Cucurbita, Citrulas, and Cucumis; that the beetles appear from the first to the middle of May on cotyledons and seed stems, and that they remain until the cold weather and until after the frost has killed the vines.

Paris green.—He states that a weak solution of Paris green is effective in destroying this insect when on the surface of the leaf.

Young plants are usually killed by eating below the cotyledons, and to avoid this and kill the insect the usual custom of melon growers in his district is to plant in squares once a week. Thus the planting numbered "1" is usually killed, and sometimes also the second and third plantings. As long as the insects show on No. 1 they are poisoned, and so on until a stand of plants is obtained. All four plantings are seldom killed.



Mr. Ernest Walker, of Clemson College, S. C., writing May 18, also states that good success in the treatment of this species accrued from the use of Paris green, particularly when applied dry, diluted with flour.

Tobacco.—Both Mr. Andrus and Mr. W. S. Stauffer contribute their testimony to the value of tobacco as a means of keeping this insect in subjection. The former states that when there is an abundant supply of tobacco waste (stems), a liberal plowing under of 1 or 2 tons to the acre is effective. Mr. Stauffer writes that during the year 1898 many of his neighbors were bothered with this insect, but that he had experienced no trouble, which immunity he attributes to the use of tobacco. In preparing soil he used tobacco ribs in lieu of manure, and as soon as the plants appeared above ground they were treated with tobacco dust, the application being repeated at intervals of a week. Plants not having the same treatment were destroyed. The ribs in the ground about the roots appeared to be more effective than the application of dust to the plant itself.

Kerosene emulsion.—Prof. W. B. Alwood, Blacksburg, Va., in a letter dated May 18, states that he uses kerosene emulsion very successfully against this species, it being simply necessary to watch the plant and observe when the first beetles appear and spray the hills early in the morning while the beetles are stupid and lie hidden under clods and around the stems in the hill, and that if this is repeated several times it enables the grower to defeat the pest. The emulsion is diluted ten times, and applied so as to thoroughly drench the soil.

Mr. A. W. Butler, Brookville, Ind., writing May 12, also states that "kerosene emulsion, prepared with sour milk or buttermilk, and applied with a whisk broom two or three times, usually gives relief" from this beetle.

"*Slug shot.*"—Mr. George Mudgett, Johnstown, Pa., writing under date of July 27, states that he has success in repelling this species from young squash plants by the use of Hammond's slug shot. Mr. Henry Holzapfel, jr., a florist of Hagerstown, Md., is also authority for the statement that this species can be overcome by the use of slug shot.

Pyrethrum.—Mr. C. P. Gillette, in a recently published bulletin (Bul. 47, Col. St. Ag. Expt. Sta., p. 40), states that he has killed this species very successfully by dusting upon them pyrethrum from a cheese-cloth sack. To be successful, however, the treatment must be made early in the morning before sunrise.

Trap crops.—Mr. J. H. Hevey, in a letter dated November 5, informed us that late squashes on his place at Ingomar, Miss., were entirely free from this beetle, a condition which he attributed to gourd vines planted in the vicinity.

In the writer's experience this species prefers cucumbers to other plants, and it seems probable that the other cucurbits could be protected by planting, as practiced by Mr. Hevey, cucumbers or gourds as a trap crop, using insecticides freely on the latter. If this should not suffice, immunity from attack should result if the main crop were dusted with sifted ashes, road dust, or plaster, as already advised in the circular on this species.

The wild cucumber, *Echinocystis lobata*, is also a favorite with this beetle and it would be worth trying as a trap crop.

THE WESTERN STRIPED CUCUMBER BEETLE.

Two of our correspondents write concerning what they designate as the striped cucumber beetle and by which they probably mean *Diabrotica trivittata* Mann., a species or subspecies which replaces *vittata*, which it very closely resembles, on the Pacific coast.

Mr. N. W. Motheral states that this species occurs at Hanford, Cal., but not in sufficient numbers to do any great amount of damage. He noticed particularly its occurrence upon ripe apricots.

Mr. E. J. Wickson, Berkeley, Cal., writing under date of May 19, 1898, states that this species is abundant in California on all cucurbits, associated with *D. soror*, which may be considered to be merely a geographical or racial variety of *D. 12-punctata*. The latter, as is well known, does great injury to fruit blossoms and to ripe fruits, but in this it is not, according to our correspondent, followed by *vittata*. The same is true of the destruction of the petals of many garden flowers.

A NEW WEBWORM ENEMY OF CABBAGE AND OTHER CRUCIFEROUS PLANTS.

The farmer and market gardener who grow cabbages, turnips, horse-radish, and other cruciferous crops, in the more Northern and Western States may consider themselves fortunate in having only such species as the cabbage louse, "cabbage worms," flea-beetles, and the diamond-back moth to contend with. In the District of Columbia and nearby localities in Maryland and Virginia the cultivation of these crops has been in a most precarious condition for several years past, the most injurious species here being the harlequin cabbage bug and the cabbage looper, *Plusia brassicæ*. If the cabbages are not completely stripped to the midrib and larger sideribs by the looper, as happened during the season of 1898, they are almost certain to fall a prey to the harlequin bug. Practically all of the cruciferous pests of the north also occur here, as well as farther south, and a host of other insects are usually present in fields of cabbage, horse-radish and the like and assist in the destruction of these crops.

To add to this there is now the threatened danger of the introduction from the South of a new and pernicious cruciferous pest, the caterpillar of a small moth, which last season caused great injury in Georgia in the vicinity of Augusta.

INJURY BY THIS WEBWORM AT AUGUSTA, GA.

Our first advice concerning injuries by this insect was received September 6, 1898, from Mr. W. M. Scott, State entomologist of Georgia, located at Atlanta. Specimens of the larvæ and adults were received in alcohol with the statement that the species was doing considerable damage in the vicinity of Augusta, Ga., to cabbage, turnips, beets, etc.

According to the report received by Mr. Scott through correspondence with persons at Augusta, the mature insect or moth lays its eggs in the heart of cabbage and other vegetables, and the larvæ soon after hatching spin a web and twist the leaves in toward the center inclosing themselves so that it is impossible to reach them with dry insecticides.

Their first appearance was noticed in August, 1897, and the species at present appears to be confined to that vicinity, although report of this or a similar species has reached Mr. Scott from Waycross, Ga.

On the 28th of September, Mr. N. L. Willet, of Augusta, sent specimens of the same larva, which is known locally as the webworm, with the accompanying statement that it had destroyed hundreds of acres of turnips, collards, and cabbages.

October 14 Mr. Willet sent additional specimens of the larvæ and made the statement that this insect had cost the county of Richmond $15,000 to $20,000 during that year. Writing November 26, Mr. Scott stated that the damage had been estimated by some sufferers at $50,000 for that county.

About a day or two later we received from Augusta another lot of specimens from Mr. Scott, who wrote on the 19th of the month that one grower at Augusta claimed to have lost $1,500 through the ravages of this insect. Soon after the plant comes up, he writes, these caterpillars begin their work by eating out the bud and cutting off the leaves near the base. In the case of turnips they sometimes gnaw holes in the top of the root. Three or four days after their work is first noticed an entire crop may be destroyed. The moths are obviously nocturnal in habit since they may be attracted by light at night, as our correspondent ascertained by taking a lantern into an infested turnip field and in a few minutes capturing dozens which flew about it.

In an article written by Mr. Willet for the Augusta Chronicle of October 9, 1898, some new facts are added which are not mentioned in his letter. Under the subheading "The garden webworm," he says, in substance, that the larva after hatching spins a web over itself, leaving a hole for egress. From the protection afforded by this web house it feeds, retiring into the web when its hunger is appeased. As the larva grows it forms a larger web. This it spins either on the upper or the lower surface of a leaf. Three or four days suffice for the larvæ to kill out a turnip patch.

One of Mr. Willet's friends was of the opinion that this species had been seen at work in some other years previous to 1898, but that it did little harm until that year. This is undoubtedly the truth, but that correspondents who are not familiar with the diamond-back moth and the true garden webworm (*Loxostege similalis*) may not confuse these insects, it should be said that their larvæ as well as adults are easily distinguished though both larvæ have the habit of living in webs on their host plants.

The parent moth lays her eggs in the bud and it requires from ten to fourteen days for them to hatch. In ordinary years the tender leaves

from the bud have grown three inches or more by hatching time, and the young larva finds itself not in the bud where it can do great harm but three inches out on the leaf. There it spins its web, and as it remains there for some time before forming a second web the harm it does to the growing leaf is trifling.

One reason advanced by Mr. Willet's friend for the severe injuries committed by this species in 1898, was that during the summer there were four or five weeks of almost daily rain. Young garden vegetables in that time made little growth and many young roots rotted. As a consequence that summer the hatching larva was not three inches out on the growing leaf but directly in the bud, which it at once devoured, thus destroying the plant. Injury was worse on turnips than on cabbage, this being due to the slower growth of the former crop. Such vegetables as grew rapidly in spite of the rains were not seriously harmed by this webworm. The gentleman whose theory we have just propounded believes that in years of forward good-growing plant weather there need be no great fear of injury by this insect.

THE SPECIES IDENTIFIED.

Some of the captured as well as bred moths were received at this time, and later some of the moths issued in our rearing cages, beginning November 21. They have been compared with material in the National Museum and found to be identical with *Hellula undalis* Fab., as identified by both Professor Fernald and M. Ragonot. The National Museum collection includes two specimens labeled "Texas, Belfrage," and the species was described from a single female, also from Texas, by Dr. Hulst (Trans. Amer. Entom. Soc., vol. XIII, p. 149) under the name *Botis rogatalis*. The type specimens were perhaps from the same source as those in the museum. In any case these are all the available data regarding the occurrence of the species in Texas, and some slight doubt attaches to its actual capture in that State, or at least to its permanent occurrence there.

In the museum collection is a third specimen collected by Mr. D. W. Coquillett in Los Angeles County, Cal., in October of 1891 or 1892. This was supposedly taken at light in the city of Los Angeles, and it seems probable that the species is also introduced at that point.

One of the Texas-labeled specimens in the National Museum bears a slip in M. Ragonot's writing: "Does not appear to differ from European type."

This is obviously a European importation and from the fact that we have never heard of its injuries until the present time, it would seem likely that it is a comparatively recent introduction. Its occurrence in two States, Georgia and California, may be due to separate introduction. Its known range includes southern Europe and Asia.

This moth is a member of the pyralid family, Pyraustidæ, and the only American representative of its genus. It is, however, somewhat nearly related to the common garden webworm, *Loxostege similalis* Gn.,

and the sugar-beet webworm, *L. sticticalis* Linn., injurious species of similar habits which have been treated in reports of this Department in rather recent years.

DESCRIPTIVE.

The moth.—The moth is illustrated at *a* of figure 12. It is gray in color with the fore-wings marked and mottled as shown. The wing expanse is about five-eighths of an inch (18 to 21^{mm}). The following technical description is copied from Dr. Hulst's paper (l. c.):

Palpi, head, thorax, and abdomen fuscous; fore wings broken fuscous and fuscous cinereous; the basal space with a black spot medially, two white lines cross the wings, the first extra basal edged with dark fuscous, the outer after the typical *Botis* pattern; a dark brown spot annulate with white at reniform; a dark brown subtriangular apical patch, and a subterminal white line; marginal line black, broken; hind wings, even fuscous; beneath, lighter, lines obsolete, reniform indistinct.

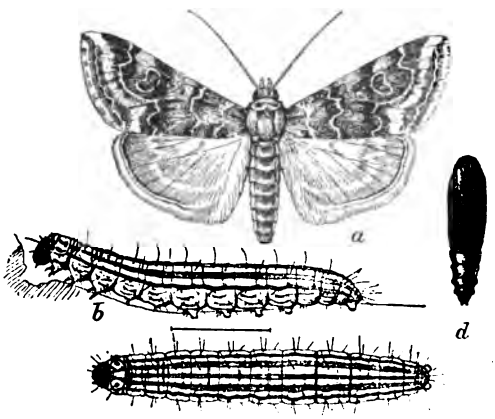


FIG. 12.—*Hellula undalis: a*, mature moth; *b*, larva, lateral view; *c*, larva, dorsal view; *d*, pupa—all three times natural size (original).

The larva.—The full-grown larva, figured at *b* and *c* of the accompanying illustration, measures a little upward of half an inch in length, being about six times as long as wide. The form is subcylindrical, tapering toward each extremity, widest near the middle—the third, fourth and fifth abdominal segments, which are nearly equal. The general color is dull opaque grayish yellow or yellowish gray, striped with broad, somewhat irregular brownish-purple, longitudinal bands, which extend from the second thoracic to the terminal or anal, segment. These are bright and conspicuous on the dorsal, and more feebly indicated on the ventral, surface. The dorsal stripes are five—a moderately wide medial one, a broader medio-lateral on each side, and a dorso lateral one, of about equal width with the median one, also on each side. On each side below are two lateral lines, faint, and interrupted toward the ends of each segment; a similar ventro-lateral line and a much fainter interrupted median line.

The head is black and shining, the V-mark well indicated, the cervical or thoracic shield is shining light, somewhat purplish, gray, and is rather variably marked with brown, which forms each side of the median stripe of the second thoracic segment, two irregular longitudinal dark brown patches, darkest and widest toward the posterior margin. On each side above the spiracle of that joint is a shorter dark patch. Near this there are sometimes two or three small dark rounded spots. The

spiracle of this segment is dark brown, the remainder being concolorous with the body. The thoracic legs are more or less infuscated, and the prolegs are nearly concolorous with the venter. The entire surface of the body is sparsely covered with moderately long yellow and light brown hairs, proceeding from small and shining piliferous tubercles.

The anal shield bears from ten to a dozen round purplish spots, the most posterior one the largest and standing alone, the remainder forming a subcrescentic pattern.

The length when in natural position at rest is about 13^{mm} and when extended 15^{mm}, the width being a trifle more than 2^{mm} at the widest part.

The pupa.—The pupa is moderately shining light yellowish brown in color and the surface is covered with a light pruinose bloom. The eyes are dark brown, varying to black and the dorsum is marked by a median stripe. The contracted antepenultimate segment is noticeable. The anal segment terminates in two pairs of straight brown hairs. It is of rather robust cylindrical form, measuring about three-tenths of an inch (7.5^{mm}) in length and one-twelfth (2^{mm}) in width. The somewhat peculiar outline of the abdominal segments is shown at *d* of figure 12.

Transformation to pupa and thence to imago takes place in a rather compact cocoon composed of white silk, which in the field is presumably spun between or upon the leaves of its host plant. Those before the writer measure about three-eighths of an inch (9^{mm}) long and a little less than half that in width.

FURTHER OBSERVATIONS DESIRABLE.

The egg is unknown and considerable remains to be learned of the life history of this insect, its full cycle of development, the number of generations produced each year, the stage and the place of hibernation, a full list of crop and other plants attacked by it, its predaceous as well as parasitic enemies, and other data of minor import.

Reasoning from analogy we may surmise that the moths make their appearance early in the season and that when the first brood of larvæ is hatched is the best time to attack the insect with insecticides, as there are probably several, perhaps as many as four generations, produced in the latitude where it is now located. Hence it is of prime importance that this time be ascertained.

PROBABILITY OF FUTURE SPREAD.

From the ease with which this pest may be transported as larva, pupa, or egg in heads of cabbage shipped from one place to another, as well as by flight of the moth, we can predict with a fair degree of certainty that its further dissemination is only a matter of time. The present seat of its depredations will undoubtedly become a center of diffusion, from which it will soon spread by flight to neighboring localities and eventually, by flight from these points or by commercial

carriage, to other Gulf and neighboring States, and it is not impossible that in due time it will gradually work its way northward from the Lower Austral region, in which it is now established, to the Upper Austral. From the proximity of Augusta to the State line of South Carolina its establishment in that State is already practically assured.

It seems probable that this pest has come to stay, yet on the other hand there exists a possibility that it may succumb, at least in a measure, to its parasitic and predaceous enemies and to climatic conditions unfavorable to its further increase. Until we know more of the distribution of the species in its supposed native home in the Old World we can not speak with positiveness of its probable future distribution in America. In any case, it is an insect that will bear close watching, and it is to be hoped that all who have the opportunity to assist in these observations will not fail to do so and to keep this Department apprised of developments.

NATURAL ENEMIES.

The natural enemies of cruciferous insect pests are of considerable value in keeping their hosts in check, and some dependence must be placed upon these agencies in restraining the undue multiplication of this webworm.

In spite of the short time that we know of its occurrence in this country, we are already certain that at least one natural enemy and probably two are at work in decimating this pest. One of these is the Tachina fly, *Exorista piste* Walk., which has been reared from the caterpillar of *Hellula undalis* at this office. The first example of this parasitic fly issued October 27.

A very abundant parasite reared with this species is the Ichneumonid, *Limneria tibiator* Cr. It was reared from the latter part of October until the last week of December. It has not been positively ascertained to prey upon this larva as it is a well-known enemy of the diamond-back moth, *Plutella cruciferarum*, which was also present in smaller numbers, but as it is also known to attack the cabbage looper, *Plusia brassicæ*, and *Mineola indiginella*, it seems probable that it is in reality an enemy of this webworm.

REMEDIAL MEASURES.

The logical remedy for this webworm is one of the arsenites, preferably Paris green, applied in the form of a spray, at the rate of about 1 pound to 120 to 160 gallons of water, upon the first appearance of the larvæ in the season and as often thereafter as the occasion may justify.

From what we already know of the life economy of this insect it is obviously a difficult species to successfully combat. The fact that the larvæ live in more or less complete concealment in webs which they form upon their food plants, and from the further fact that there are undoubtedly several generations produced during the season, it follows

that the closest observation will be necessary to keep it in subjection, that the application of poisons may be made at the proper time and not when too late to be of substantial value.

In addition, it will be a wise precaution, as we have advised our correspondents, to destroy every bit of vegetation which remains in the gardens or fields which this insect infests after the crops are harvested. This would include the complete and prompt destruction of cabbage stalks and similar refuse material, and the raking up into piles of all other débris, including weeds, and setting fire to them at once and without waiting for them to dry, by adding straw, dried leaves, or other material which will aid in their ignition.

It is not improbable that if the earnest cooperation of farmers and truck gardeners of Augusta and vicinity with the State authorities could have been obtained this pest might have been stamped out, but under the present circumstances it is likely that this insect will be troublesome again next year and in the future, and that it will spread to neighboring localities and thence throughout the South.

NOTES ON THE GARDEN FLEA-HOPPER.

(*Halticus uhleri* Giard).

RECENT OCCURRENCES.

In very recent years a minute black bug of the family Capsidæ, known in collections generally as *Halticus bractatus*, has been the occasion of more or less reported injury to beans and other vegetables, as well as to a variety of other plants.

June 29, 1895, Mr. James A. Turner, a florist of Salem, Ohio, wrote that this species, specimens of which were sent, was very destructive to smilax in his greenhouse.

August 5 of the following year Mr. G. M. Dodge, Louisiana, Mo., sent specimens with the accompanying information in a letter of that date that this species was troublesome that year, when it for the first time came under observation. It was first noticed on late potatoes, where individuals were present in great plenty. The effect of its work was to turn the leaves a pale sickly color. It was also observed to be working in clover, a small piece adjoining the potato patch being so drained of its juices that the new growth after being first cut looked white at a little distance. It was also stated to have injured tomatoes and corn. A number of other vegetables were attacked to a less extent, but by way of partial compensation the bugs also fed abundantly upon the wild horse nettle, *Solanum carolinense*, and on *Ipomœa purpurea*, or an allied species of wild morning-glory. By later mail our correspondent sent leaves of red and white clover, Ipomœa and pumpkin, showing work of this species, but the statements made in the previous letter that corn, potatoes, tomatoes, and horse nettle were also affected needs confirmation. This is especially true of corn, as it

would be an easy matter to mistake one of the flea-beetles of the genus Chætocnema for this bug. Personally the writer is inclined to believe that the other plants mentioned are true food plants of this species, as he has found it in considerable abundance on egg-plant in the vicinity of the District of Columbia, and Mr. C. W. Mally has observed it also feeding on ground cherry, *Physalis pubescens*, plants of the same botanical family, the Solanaceæ.

During the season of 1897, from the middle of July until about the middle of September, this species was noticed in abundance by the writer at Kensington and Marshall Hall, Md., on beans, peas, and cow-peas, but most abundantly on beans. At this latter date specimens were brought to this office by Mr. R. Balluff from the flower garden attached to the Executive Mansion at Washington, with the report that these bugs were injurious to several plants, particularly chrysanthemums.

During 1898 word was received from Mr. J. F. Collins, curator of the herbarium at Brown University, Providence, R. I., under date of August 14 that these bugs were found in numbers on a lawn at that place. The grass was apparently dead, and brown patches, in some cases nearly two feet across, were conspicuous and believed to be the result of the work of this insect.

LITERATURE.

The economic literature of this insect is limited. The species was originally given the name *Halticus minutus* MS. by Dr. Ph. R. Uhler (E. A. Popenoe, Rep. Dept. of Hort. and Ent. Exp. Station Kansas, Sec. Ann. Rep. 1889 [also Bul. 10, Dec., 1890], p. 212, Pl. IX, figs. 10, 11, and 12); and although the species was figured and briefly described by Professor Popenoe under that name, the technical description does not appear to have ever been published. Unfortunately, the specific name *minutus* is preoccupied, a species having been described as *Halticus minutus* Reut. from three winged females found at Singapore, Malay Archipelago (see Giard's article, Soc. de Biol., Compt. Rend., 1892, 9 ser., vol. IV, pp. 79–82). In accordance with a well-established rule in the case of preoccupied names, M. Giard proposed the name *Halticus uhleri* for the American species.

Dr. Uhler, in a paper published in the Proceedings of the Entomological Society of Washington (vol. II, p. 378, June, 1893), contributes some notes on this insect, mentioned as *Halticus uhleri* Giard. From this the following paragraph is quoted:

> This species is now known to be widely distributed in the United States, and in many localities of Maryland, Virginia, and Pennsylvania it is extremely abundant upon cabbages in the gardens. It has been found a few times by the writer upon burdock, *Lappa major*, in the neighborhood of Baltimore. The leaves of this plant were almost covered by the great number of these little flea-like hoppers, which jumped off into the surrounding soil upon the lightest approach of the collecting net. It occurs fully winged in July, but the greater number of the females appear in the unfinished state, which preserves the more robust and convex figure, with the short and completely coriaceous wing covers.

Our first economic account appears to be that, previously referred to, by Professor Popenoe, in which he mentions this species and *Agalliastes bractatus* Say, in connection with their injury to beans in Kansas. They were observed during the season of 1890—

> living in great numbers on the underside of the leaves of the garden bean, puncturing the tissues and sucking the sap, and by these punctures causing the death of the tissues in small, irregular patches that appear upon the upper surface of the leaf as white spots. These two species are so nearly alike, so far as habits are concerned, that they may be noticed together. They operate mostly near the ground and upon weak, low-growing sorts. They sometimes do appreciable injury to the plant. The insects of both species are able to jump many times their own length, and when disturbed they hop from the leaves like flea-beetles. They have also been observed to feed upon red clover in the manner and with the effect described above.

During the season of 1896 this species was the occasion of considerable injury to red clover and some other plants in the State of Ohio, and was so reported by Mr. F. M. Webster (see Bul. 6, n. s., Div. Ent., Dept. Agric., p. 68; Ent. News, vol. VIII, pp. 209, 210).

In the Annual Report of the Entomological Society of Ontario for 1896 (pp. 83, 84) Mr. Webster also has some remarks on this species and its supposed mimicry of *Chætocnema parcepunctata*, which also occurs on red clover.

In the article first quoted the species is stated, on the authority of Mr. C. W. Mally, to have been found also feeding on cucumber near Cleveland, and to occur in Iowa. Particular attention is called to the fact that farmers, "without a single exception," call these insects flea-beetles, an error which is excusable when we consider the close resemblance of the saltatorial and wingless females to species of Chætocnema and Epitrix. In the second article, which bears the title "*Halticus bractatus* Say," and which is illustrated by a plate of two figures of wingless and winged females, some additional facts are given, including a long list of food plants. Unfortunately, Mr. Webster has designated his fig. 1 as the male, an error which becomes readily obvious when comparison is made with the illustrations accompanying this article.

The illustrations furnished by Professor Popenoe in all probability represent the two sexes, male and wingless female of one species, an opinion which has already been expressed by Mr. Webster, and one in which Mr. Otto Heidemann of this Division, who has made a specialty of the Capsidæ, fully concurs.

DESCRIPTIVE.

Say's species, originally described by him as *Capsus bractatus*, and evidently drawn from the winged female (Complete Writings, Lec. ed., vol. I, p. 348, 1859), differs from the form under consideration so far as has been pointed out only in size, the former being the larger. In specimens before the writer of the brachypterous female of both species, *bractatus* measures about 2 to $2\frac{1}{2}$ mm in length, while *uhleri* is but little

more than half that. The color of all forms is shining black, the lighter portions of the antennæ and legs shown in the illustration being pale yellow. The hemelytra are ornamented with rather sparse scale-like tufts of yellow hair, arranged as in the illustration. These are readily detached, and hence apt to be wanting in old dried material. The dimorphic brachypterous or wingless female of *uhleri* is shown at *a*, the winged female at *b*, and the male at *c*. The true male, as identified by Messrs. Uhler and Heidemann and verified by specimens captured *in coitu*, is much narrower and shorter than the full-winged female, and the hemlytra are subparallel, not roundly oval as in the female. The front and middle femora are yellow, whereas the female has the femora with only the knees yellow or dull whitish.

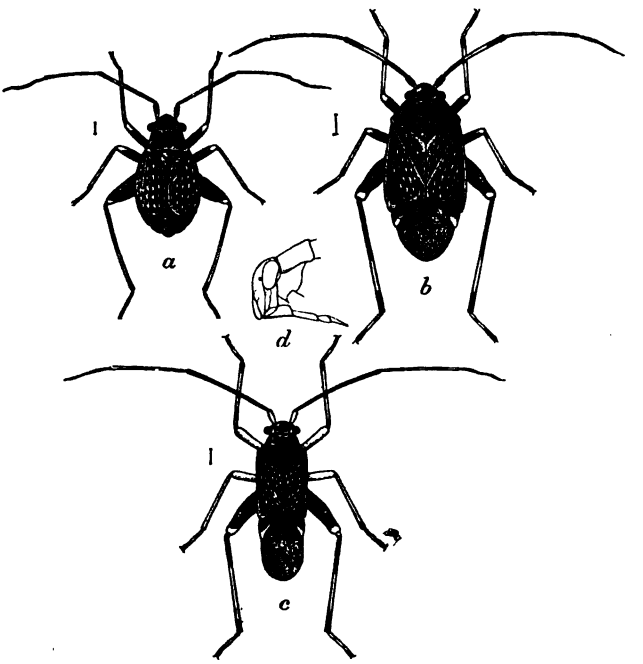


FIG. 13.—*Halticus uhleri*: *a*, brachypterous female; *b*, full-winged female; *c*, male; *d*, head of male in outline—all much enlarged (original).

DISTRIBUTION.

The following localities are known for this species: Grimsby, Ontario, Canada; Holderness, N. H. (Heidemann); Providence, R. I.; York County, Pa.; Vineland and Egg Harbor, N. J.; Newark, Del. (Beckwith); Washington, D. C.; Baltimore, Kensington, and Marshall Hall, Md.; Salem, Cleveland, and elsewhere in Ohio; Cobbs Island, (Heidemann), Berkeley Springs, Va.; Rock Island, Ill.; Iowa; St. Louis and Louisiana, Mo.; mountains of North Carolina; Orange Springs, Fla.; Riley County, Kans.; American Fork Cañon, Utah.[1]

[1] "*Halticus bractatus* Say" is recorded from Manitou and Colorado Springs, Colo. (Gillette and Baker, Bull. 31, Agr. Expt. Sta. Colo., p. 46).

Of the localities above given, all except those personally credited or represented by specimens have been previously recorded and credited by Dr. Uhler (l. c.) and others or have been mentioned in the preceding pages. The above localities show a distribution which ranges from what is known as the Gulf strip of the Lower Austral life zone to the Boreal zone. There are no reasons for the belief that this species is other than native to this country.

ADDITIONAL FOOD PLANTS.

In addition to the food plants already recorded, the following are given by Mr. Webster (l. c), based on Mr. Mally's observations: Prickly lettuce, *Lactuca scariola;* ragweed, *Ambrosia artemisiæfolia;* white vervain, *Verbena urticæfolia;* narrow plantain, *Plantago lanceolata; P. rugelii;* selfheal, *Prunella vulgaris;* smartweed, *Polygonum hydropiperoides;* mares tail, *Erigeron canadense;* thistle, *Carduus lanceolatus;* sticktights, *Bidens* sp.; low mallow, *Malva rotundifolia;* yellow sweet clover, *Melilotus officinalis;* sour grass, *Oxalis stricta; Aster* sp.; crab grass, *Panicum sanguinale.*

THE LIFE HISTORY NOT WELL KNOWN.

This species, like many other injurious forms, is subject to considerable fluctuation in numbers in different seasons. During 1898 it was extremely rare in the vicinity of the District of Columbia, only a few specimens being found when sought for on clover, which appears to be one of its favored host plants. It practically disappeared late in September, as no bugs could be found when sought for in early October.

Mr. Heidemann has observed this species (principally on red clover) in the District of Columbia as early as May, but it may occur somewhat earlier, and he has expressed the opinion to the writer that there are probably two generations in this latitude. He also inclines to the belief that injury to potato and similar garden crops is usually in the vicinity of clover fields and apt to be the direct outcome of the cutting of the clover, which results in some instances in the practical withdrawal of the insects' natural food supply, thus forcing them to attack the nearest or most available crops. Mr. Webster has said that this species might hibernate in the adult stage, although it would seem that it usually passes the winter in the egg; but this is practically mere conjecture, as no positive observations on these points which can lead us to generalize with accuracy have been made. He has noticed its occurrence in greenhouses and kept specimens of the adults living in the insectary at Wooster, Ohio, during the winter. From this it is not improbable that still another generation, if we can prove that two are produced out of doors, might be developed in a warm indoor temperature.

As no common name appears to have become attached to this insect, the writer proposes that it be known as the garden flea-hopper.

REMEDIES.

The most feasible method of treatment that suggests itself is the use of kerosene in some of its forms. A spray of kerosene emulsion, as strong as the plant will bear without injury, would doubtless be effective in the destruction of the bugs in all stages, or they might be jarred from the plants upon which they are feeding onto sheets saturated with kerosene or into pans of water on which a thin scum of kerosene is floating.

For the mechanical method of treatment it would be preferable to go over the infested plants early in the morning or late in the day before dusk, when the insects are less active than in the bright sunlight.

THE IMBRICATED SNOUT-BEETLE.

(*Epicærus imbricatus* Say.)

RECENT INJURY.

Specimens of this snout-beetle were received May 10, 1898, from Mr. David Font, Garfield, Ark., with the information that they were very

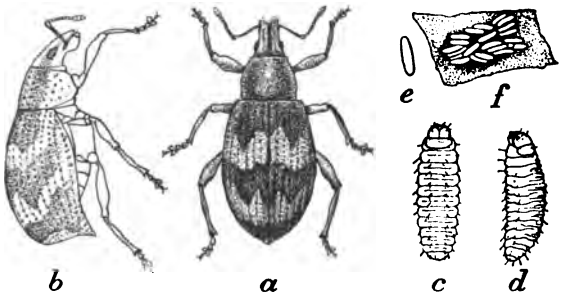


FIG. 14.—*Epicærus imbricatus: a*, female beetle; *b*, same from side; *c*, newly hatched larva; *d*, same from side; *e*, egg; *f*, egg mass.—*a*, *b*, about three times natural size; *f*, two times; *c*, *d*, *e*, more enlarged (original).

destructive to strawberry plants, eating the leaves and afterwards the entire stem. They appeared in that vicinity about April 10. From material received at this time eggs and larvæ were obtained, from which certain studies were made and the accompanying illustrations prepared.

There is at least one other record of this beetle being injurious to strawberry—that published by Messrs. Osborn and Mally (Bul. 32, Iowa Agr. Coll. Expt. Sta., p. 395). Although the species, in its adult state, at least, is what is termed a general feeder, these two instances will serve to secure it a permanent place in the list of enemies to this fruit. From its wide distribution and its omnivorousness it has received frequent mention in literature in spite of its being only periodically destructive, and only in the adult condition so far as known, since the time of its first notice as an injurious insect thirty-five years before the time of the present writing.

DESCRIPTION OF THE SPECIES; DISTRIBUTION.

The imbricated snout-beetle, as its name indicates to the student of entomology, is a member of the superfamily Rhynchophora, the weevils or snout-beetles, and of the family Otiorhynchidæ, or short-snouted weevils.

The beetle.—The beetle was first described by Thomas Say in the year 1824 (Journ. Acad. Nat. Sci. Phila., vol. III, p. 317), from Arkansas, as *Liparus imbricatus*. It is one of our largest weevils, measuring from about three-eighths to nearly half an inch in length, and is of the general appearance indicated in the figure at *a* and *b*. The body is covered with minute imbricated scales (whence the insect's name), the lighter portions appearing as brownish gray, the darker as light brown, the latter arranged on the elytra in bands, as shown. The head is prolonged into a rather short, broad snout, with elbowed antennæ, and the elytra into a point, as shown at *b*.

Distribution.—This is a widely distributed species, occurring in most of the States, except the more northern ones, east of the Rocky Mountain range. In the Boreal zone it does not appear to be represented, and in the transition rarely, if it occurs there at all.

The following list of localities is taken from divisional and published records, from material in the National Museum (which includes the Hubbard and Schwarz collection) and in the writer's collections: New York City (vicinity); Camden and elsewhere in New Jersey; Newark, Smyrna, Felton, Del.; District of Columbia; Baltimore, Locust Grove, Md.; Strasburg, Oaktown, Herndon, Rosslyn, Falls Church, Va.; Madisonville, Stillwater, Tenn.; Horse Cave, Ky.; Garfield and elsewhere in Arkansas; Agricultural College, Mich.; Cramer, Ill.; Iowa; Louisiana; Sedalia, Hallsville, and elsewhere in Missouri; Tonganoxie, Clay County, Kans.; Stillwater, Okla.; Catoosa County, Ga.; Cypress Mills, Columbus, New Braunfels, San Diego, and elsewhere in Texas; New Mexico; Colorado; Wasatch, Utah.

The egg.—Elongate, more than three times as long as wide, somewhat variable in outline owing to close deposition, subcylindrical, sometimes slightly curved on one side, broadly rounded at each end; surface smooth, shining, with no apparant sculpture; color light dull yellow, becoming subtranslucent, first at base and afterwards at apex; consistency rather firm, being readily detached from the surfaces of deposit. Length: 1.50 to 1.60^{mm}; width 0.48^{mm}.

The egg is figured in outline at *e* of the accompanying illustration, *f* showing an egg mass.

The newly hatched larva.—The young larva when first hatched is uniform whitish yellow and no ocelli are visible, but the color deepens in a day or two, the head becomes honey yellow, the thoracic shield becomes evident and a pair of ocelli placed as shown in the illustration (*c* and *d*) may be plainly seen on each side. The mouth-parts also become darker, the tips of the large, prominent mandibles showing

dark brown in color. The entire body, including the anterior portion of the head, is sparsely covered with whitish pubescence. The head is retractile and there are no signs of legs, but in their place each thoracic segment bears on its ventral surface a pair of rather strong bristles which are evidently of assistance to the larva in crawling. In the contracted position assumed upon death the larva measures about 1.5mm, the diameter being about one-third as much.

The mature larva and the pupa are unknown.

LITERATURE.

The first notice of this species published was by the veteran economic entomologist, Benjamin D. Walsh, who gave an illustrated account of it in the Prairie Farmer of July 18, 1863 (p. 37), based on the statement of an Iowa correspondent, who wrote that the beetles were "doing great injury to apple and cherry trees, as well as gooseberry bushes."

In the year 1871 the late Dr. Riley published in his third Missouri Report (p. 58) a short note on this species, drawing attention to the fact that the beetle is quite frequently met with on different fruit trees, doing considerable injury to the plants mentioned by Walsh, in gnawing the twigs and fruit. He stated that the species is a native of the more Western States and found much more commonly in the western part of Missouri, in Iowa, Kansas, and toward the mountains, than on the "eastern side of the great Father of Waters."

The species next attracted attention in 1879, receiving mention in Professor Comstock's annual report as entomologist of the Department of Agriculture in that year (p. 249). Beetles were received June 1, 1879, from Madisonville, Monroe County, Tenn., with the remark that they were injuring onions. Onion stalks accompanying the communication were riddled with holes gnawed by the beetles. Later, a report was received from Sweetwater, in the same county, that these beetles had injured a field of 2 acres of onions, one-fourth of the crop having been destroyed. The beetles were stated on the authority of Mr. Thos. G. Boyd to have made their appearance on early vegetables as fast as the crops came up. They were noticed upon onions in February and were reported to have destroyed radishes, cabbages, beans, watermelons, muskmelons, cucumbers, squashes, corn, and beets.

The following year the species was reported by Dr. Riley to have been received from Felton, Del., with the statement that it was "destroying early cabbages, eating the leaves and sucking the juice from the stems." The fact was also brought forward that this species was quite injurious to corn in 1873 (Amer. Ent., vol. III, p. 200). In the annual report of this Department for 1884 (pp. 300, 301) the same writer also treated of this beetle somewhat at length, but without adding any new facts worthy of mention to what has been previously reported.

In 1882 Prof. S. A. Forbes found this species feeding on red clover blossoms (12th Rept. St. Ent. Ill., p. 104), and in 1886, in a paper before

the American Association for the Advancement of Science, mentions its feeding on pear leaves. He also ascertained that the insect laid its eggs (in confinement) on leaves, concealing them by gumming the leaves together. Later, in 1890 (16th Rept. State Ent. Ill., p. 76), he demonstrated by experiment and dissection that the species feeds freely on grasses.

Brief mention of attack on the foliage of fruit trees at Herndon, Va., in 1887 was given in Insect Life (vol. I, p. 59).

In 1889 Dr. Clarence M. Weed gave an account of this insect (Ann. Rept. Ohio Agl. Expt. Sta. for 1888, pp. 167, 168), together with an abstract of a letter from Mr. J. P. Coulter, of Cramer, Ill., who reported its abundance on potatoes, and that it was "fully as destructive as the Colorado potato beetle, from its habit of cutting off the stalks, with their soft, undeveloped leaves."

Injury to young apple trees was reported in 1891 from Stillwater, Payne County, Okla. (Insect Life, vol. IV, p. 77).

In the Eighth Annual Report of the Kentucky Agricultural Experiment Station for 1895, Mr. H. Garman mentions reported occurrence of this species on strawberry at Horse Cave, Ky., April 30, of that year.

In Colman's Rural World of June 6, 1895 (p. 177), is a short notice, consisting of a letter of inquiry from a correspondent in Hallsville, Mo., and answer by Miss M. E. Murtfeldt. Specimens of the beetles were received by the latter and identified as this species, and the report was given that they were found in some numbers on young pear and apple trees.

Several other notices than those above mentioned have appeared in regard to injuries by this insect, but as they add but little to our knowledge of the insect's habits, they need not be quoted here.

DIVISIONAL AND PERSONAL NOTES.

Among divisional notes other than those published and previously mentioned are records of the receipt of this species from various correspondents, among which may be mentioned the following (all communications were accompanied by specimens of the beetle):

May 6, 1891, from Mr. H. J. Lamb, Stillwater, Okla., destroying young growth of apple trees. April 24, 1893, Mr. Theo. Pergande found between the terminal leaves of *Cassia marilandica* growing on the flats between the canal and the Potomac River above Georgetown, D. C., two batches of eggs belonging to this species. The leaves were glued tightly together with the eggs between them in the same manner as is always observed when eggs have been obtained in confinement, being placed more or less regularly in rows. April 25, 1895, the beetles were reported in a raspberry patch near Strasburg, Va. May 13, 1895, from Stark Brothers, Louisiana, Mo., found on apple. May 19, 1896, Mr. M. H. Beckwith, Newark, Del., reported that the beetles were feeding on plum and peach near Smyrna, Del. June 1, 1897, from Mr. T. J.

Shallcrop, Locust Grove, Md., who stated that the beetles were injuring tomato plants at that place. The beetles were taken May 17.

The writer has noticed on various occasions the abundance of this beetle on the leaves of young locust and blackberry, but particularly on the former. Attempts to rear the species were unsuccessful, though undertaken on two different occasions. Both Mr. Pergande and the writer are of the opinion that the larvæ will be found eventually to feed chiefly at the roots of some leguminous plant and quite possibly on Cassia and perhaps locust, as the eggs were found in nature on the former and the beetles occur commonly on the latter wild food plant.

The beetle possesses the habit of "playing 'possum" or feigning death, so prevalent in the rhynchophorous group, to a remarkable degree, dropping off its food plant upon the slightest disturbance, and remaining with its legs and antennæ tightly appressed to its body for some time before resuming activity. The writer has observed this insect in rather more abundance upon plants growing on sandy soil, and its colors harmonize with the same upon which it drops.

EGG LAYING.

A pair of this species received May 14, 1898, from Garfield, Ark., and sent us under date of May 10, were placed in a small rearing jar with leaves of strawberry May 16, and egg deposit ensued, as will be shown by the accompanying figures, each numeral representing a separate batch of eggs. No eggs were found after May 24 until June 3, the beetles continuing paired and evidently copulating until that time. It is not impossible, however, though hardly probable, that eggs were deposited during this time and escaped observation, as it was noticed that after the death of the male, which occurred June 11, the female frequently turned over one of the serrated points of a leaf and cemented it so neatly to the leaf that it would not readily be noticed. In one case a nidus thus formed was cut by the weevil from the leaf.

Date.	Number of batches.	Date.	Number of batches.
May 17–19	5, 6	June 18	19
May 19–20	4, 7	June 19	9
May 21–22	1, 2, 14, 3, 21	June 20	8, 3
May 23–24	11, 21, 24	June 21	10
May 22–June 2	0	June 22	13
June 3	19	June 23	0
June 4	19	June 24	5, 7, 3
June 5	11	June 25–26	9, 7, 13
June 6	0	June 27	0
June 7	15, 9	June 28	15
June 8	9	June 29	2, 22
June 9	0	June 30	11
June 10	11	July 1	19
June 11	8	July 2	18, 6
June 12	19, 4	July 3–4	8, 10, 4
June 13	17	July 5	5
June 14	20	July 6	0
June 15	12		
June 16	9	Total	540
June 17	7, 6		

Up to June 29 the writer had been under the impression that oviposition occurred chiefly toward the close of day and in early morning, and as a consequence no effort was made to observe egg deposit. The rearing jar was usually inspected early each morning, although sometimes later, and the female almost invariably dropped from the leaf and feigned death in the usual manner. On this morning, however, she held her ground, and it was seen that she had just begun egg deposition, a single egg having been laid. She had first joined the leaves together, and when found had her ovipositor and terminal segments extended between them.[1]

This individual died July 7, having lived, to our certain knowledge, an active life of fifty-seven days, in addition to the time before and during hibernation. In this time she deposited eggs almost daily. It will be seen by the above figures that a total of 540 eggs were laid in this time, and it is probable that the entire quota might reach as high as 600, as there is little doubt that egg laying had at least begun before the receipt of this individual and her partner, and dissection showed at least a dozen more eggs unlaid. Small masses of eggs, it will be observed, are rather the exception, the largest mass deposited being twenty-four.

Eggs that were laid May 19 hatched June 3, or in fifteen days; another lot, laid at this latter date, hatched June 15, or in twelve days; and a third lot, deposited July 1, hatched on the 11th of that month, or in ten days. The difference in time is, of course, to be accounted for by the difference in temperature, the last period being warmest. All the eggs deposited were fertile.

REMEDIES.

This weevil will yield to the same remedies employed against the Colorado potato beetle—arsenicals applied either dry or in spray at the rate of a pound to 100 gallons of water; or the beetles may be jarred from the plants onto specially prepared cloths or other receptacles freely saturated with kerosene.

THE BROWN FRUIT-CHAFER.

(*Euphoria inda* Linn.)

This species was first observed during the season of 1898, on April 1. Two individuals, one a female, were captured soon afterwards and placed in a rearing jar with moistened sand, in the hope that a sufficient number of the beetles would afterwards be obtained to warrant

[1] In the deposition of its eggs this species resembles the parent of the apple-root borer, *Leptops hopei*, an Australian weevil of destructive propensities. This species is described by Mr. C. French (Handbook of the Destructive Insects of Victoria, pt. II, p. 94) as ascending the branches of the apple tree at night and with her legs folding the leaves together, fastening them with a glutinous secretion; then after depositing her eggs she holds the folds of the leaf together until they stick.

experiments. One beetle died in a few days, and as no more were captured no further attention was paid the matter until May 31, when examination of the sand showed the presence of both eggs and larvæ—six of the former and three of the latter. All of the remaining eggs had hatched by June 2, when another had been deposited. From this lot the accompanying observations were made and the descriptions which immediately follow were drawn.

DESCRIPTIVE.

The egg.—The egg is nearly spherical, resembling in miniature those of certain of the smaller owls. It is of quite firm consistency and elastic. The color, when newly laid, is perfectly white, and rather moderately polished, but with age this becomes darker gray and opaque. There is no visible sculpture. The size, when freshly deposited, is about 1.75^{mm} by 1.50^{mm}, but by absorption this becomes, immediately before hatching, about 2.65^{mm} by 2.18^{mm}, or at least a third larger. An egg is shown in outline at *b* of figure 15.

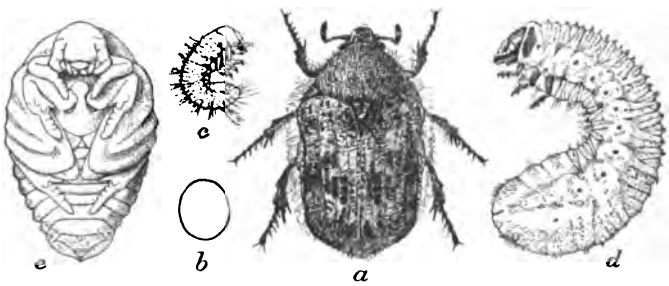


FIG. 15.—*Euphoria inda:* *a*, beetle; *b*, egg in profile; *c*, larva newly hatched; *d*, full-grown larva; *e*, pupa—all about twice natural size (original).

The newly-hatched larva.—The larva, when first hatched, is nearly white in color and moderately hairy. The head is dull yellowish, as are also the terminal joints of the legs. The mandibles are brown, becoming dark toward the extreme toothed tips, and, by comparison with those of Lachnosterna, are small. The general appearance of this stage is represented in the illustration at *c*. When extended at length, it measures about 4.5^{mm} by 1.7^{mm}.

The mature larva.—The larva when fully matured presents the appearance of *d* of the accompanying figure. It is far more robust than Lachnosterna, the abdomen particularly being much swollen, while the legs are much shorter, the head smaller, and the mandibles less prominent, in which respects it resembles Allorhina. The spiracles are prominent, and in front of the spiracle of the first thoracic segment there is a yellow corneous plate of subtriangular outline. Upon attaining full maturity the larva reaches a great size; the skin becomes distended with the contents of the abdomen, which imparts to the lower moiety of the body a dull deep leaden hue not indicated in the illustration. A larva

which was measured when exactly 2 months old was when extended 26.5^{mm} long and 9.5^{mm} wide, but when it had increased to its maximum size it was somewhat over 30^{mm} in length and 10^{mm} in width, being a little more than a third wider than long. Before transformation to pupa the larva shrinks to about half its former size, and with the absorption and discharge of the contents of the abdominal canal becomes light yellow in color. The head is moderately shining deep honey yellow, with the lower portions darker, deep brown at the sutures, the mandibles nearly black. The legs are lighter, as also the prothoracic shield.

The pupa.—The pupa is sufficiently well shown by the accompanying illustration (fig. 15, *e*) to obviate the necessity of a detailed description. It is light yellow in color and takes on a brownish tint before transformation to adult, the elytral pads, legs, and mouth-parts being a shade darker than the other portions of the body. It measures about 15^{mm} in length and 9^{mm} in width at the widest part, which is near the middle.

Transformation to pupa takes place in a substantial cocoon, which is smooth and regularly oval within and rough and irregular on the outer surface. The cocoon has a protuberant spot on one side, probably the under surface, and due perhaps to the excess of fluid which is voided by the larva during its construction. The cocoons before me measure from 17 to 20^{mm} in length and 14 to 16^{mm} in width on the outer surface. In transforming the larva pushes its shed skin down into a bunch at the anal extremity.

The adult.—The general appearance of the adult beetle is shown at *a* of the illustration. It is of robust form, with a triangular thorax. The ground color is brown; the thorax is nearly black, with a few yellowish markings toward the base of the elytra; the elytra and scutellum are light yellowish brown mottled with black markings arranged in a variable pattern, but usually approaching that shown in the illustration. Nearly the entire surface, except the elytra, is covered with a coating of yellowish gray pubescence, which is long and thick on the under surface, particularly on the thorax and legs. Its length is from one-half inch to considerably more (12 to 14^{mm}), and the width is about five-eighths of an inch (7 to 8^{mm}).

This species occurs practically everywhere in the United States east of the Rocky Mountains, as also in Canada. It is most abundant in the North, its place in the South being filled by other more numerous congeneric insects of several species.

OVIPOSITION.

The record of egg laying as observed is as follows:

April, probably none; May, nine; June 2, one; 3, four; 4, two; 6, five; 7, ?; 8 to 10, ?; 11 and 12, seven; 13, four; 14, three; 15, one, when egg laying ceased, the beetle dying about the 19th.

During three days from the 8th to the 10th this beetle was free in the office room, having escaped from the rearing jar in which she had been

confined. On the 9th a peculiar buzzing sound, as loud as that of the largest bumble bee, was heard near the window, and again on the 10th, when the beetle was discovered and returned to the jar.

This individual had been supplied with strawberries, the only fruit available, but had not partaken of these or of any food whatever. The sand with which her rearing jar was supplied was kept moist, and a certain degree of nourishment may have been furnished by this. Practically speaking, she lived eighty days without food, during which time 36 eggs were deposited. Upon dissection of the beetle a large number of eggs in different stages of development were found, upward of a hundred by estimate, but as decomposition had set in the exact number was not ascertained.

HABITS OF THE LARVA.

The value of recording fragmentary observations, if careful and conclusive, is well exemplified in the case of the present species. The writer's first notes on the larva were the first to shed any light on its true habits, and were totally at variance with those previously conceived by entomologists. LeBaron, who wrote of this species in 1874 (Fourth Ill. Rept., p. 91), was of the opinion that the larvæ lived in rotten wood. The general impression of naturalists was, I believe, that the larva fed upon rootlets of grass and other herbaceous plants, while certain few expressed the opinion that the larva was in some manner dependent upon the friendly assistance of ants, this belief being based upon their known occurrence in ants' nests.

The larva, as was first pointed out by the writer in volume VII of Insect Life (p. 272), feeds, like that of the allied *Allorhina nitida*, or green June beetle, in manure and in rich soil containing an abundance of humus, and not upon the roots of grass and other herbaceous plants, as was previously supposed. The observations of the writer on the species referred to were made in July and August of 1890, and were interrupted as previously explained by an unlooked-for absence.

Mr. M. V. Slingerland during the year 1896 obtained larvæ in manure, and succeeded in rearing the species and in making certain observations and descriptions of the same, the details of which have been brought together in an illustrated article published in the Canadian Entomologist for March, 1897 (vol. XXIX, pp. 50–52).

Mr. Slingerland wrote that "the dull leaden hue of the body, due to the contents of the food canal, indicated that its food consisted of dead vegetable matter rather than living roots." There was no evidence of the larva having fed on the roots of living plants.

Dr. J. A. Lintner, in his twelfth report as State entomologist of New York for 1896 (1897), page 314, states that according to the observations of Botanist Peck larvæ in manure were placed on a few hills of corn in a garden, and that on the following day one of the hills was noticed to have been cut down as if by cutworms. Upon digging around the stalks two larvæ of Euphoria but no cutworms were discovered—

evidence, it was thought, that these grubs committed the injury. Even though this were true, which is not probable, it would not conflict with the statement that the normal food of the larva is manure and humus and the plant-feeding habit exceptional.

Among the unpublished notes of the late Dr. Riley, made many years ago and on file in this Division, are some remarks which if published earlier might have thrown some light upon the life habits of this species, or at least suggested what the natural habits of the larva were. July 10, 1874, larvæ which were afterwards reared to the adult were found to have eaten the balls of manure made by the common tumble dung beetle, *Canthon lævis*, which happened to have been placed in the same tin box. Later balls of manure of the tumble dung were furnished to these larvæ, which fed upon them.

The other notes will be briefly mentioned in their proper place later on in this article.

About a score of the larvæ of nearly the same age (some having increased somewhat in size from the small amount of nutriment which they had been able to obtain from the sand in which they had developed) remained after a sufficiency was preserved for permanent deposit in the National Museum collection. These were used in experiments to determine the food habits and injuries that might be effected by them. The experiments began June 27. One lot was placed in a small pot with a small strawberry plant, another with a strawberry plant which did not look particularly thrifty, and a third was placed in a rather large pot with manure and earth, and a fourth was placed on a patch of strawberries on the experimental plat.

The sickly plant did not wholly recover, but the healthy one, when examined July 22, was found to be still sound in every particular. In both of these pots the larvæ had reached a length of a little over half an inch (14^{mm}). In the manure the larvæ were much larger, having attained a length of nearly an inch (23^{mm}). No evidence of the presence of the larvæ in the strawberry patch could be detected.

Previous experience, together with these experiments, although on so small a scale, very conclusively prove that the larva of this species is not injurious except perhaps under the most exceptional circumstances, and that it feeds practically exclusively on humus and not upon roots, thus agreeing in its habits with the observations of Dr. Howard and others on the allied *Allorhina nitida*.

The larvæ travel on their backs with equal facility to those of the latter species, but appear to possess rather less speed; still, with the assistance of the rows of short stiff bristles on the dorsum, they crawl by undulating motions with considerable rapidity.

Of other points in the life history of this species Mr. Slingerland wrote:

> Doubtless the beetles hibernate, but whether egg-laying takes place in fall or spring is not known. The fact that manure piled in August and October contains many nearly full-grown grubs the next June indicates that the eggs are laid and

hatched in the fall. Otherwise the grubs must develop very rapidly after hatching from eggs laid in the spring. There seems to be one brood of the insect in the course of a year.

All of this is true except the surmise in regard to the eggs being laid and hatched in the fall. Egg-laying probably begins as early as the first of May, and perhaps earlier, which will account for the larvæ being observed so well developed in June. The period of egg-laying is, of course, variable. Eggs that were laid June 2 hatched on the 13th, or in eleven days.

From larvæ that hatched from the egg during the third week of June a pupa was obtained which would have transformed to beetle about September 8. The period of the larvæ under observation was between eight and nine weeks from hatching to transformation to pupa, and the pupa stage, according to Mr. Slingerland's observations, is about sixteen days; larvæ that transformed to pupæ July 28, he says, issued as beetles August 13. These figures would give a period of the life cycle from the deposition of the egg to the maturity of the beetle of about twelve weeks.

Experience shows that the beetles normally, if not always, leave their pupal cells in the fall to feed, and that the species hibernates in the adult condition.

FOOD HABITS OF THE BEETLE.

Although this species is not injurious in its larval state, it is quite the contrary with the adult, but even here injury is probably often very much exaggerated, as the mouth-parts of the beetle, as well as those of other species of the same group of Scarabæidæ, the Cetoniini, are formed rather for sipping or lapping of vegetable juices than for boring or chewing. The beetles feed indifferently upon the sap which exudes from wounds in trees and upon the juices of over-ripe or injured fruits or other succulent vegetable growth and upon pollen. Their active life as beetles is comparatively short in the fall of the year. They appear toward the end of August and the first of September, the date of appearance varying with locality; but in a short time, a matter of about two or three weeks, they cease feeding and enter the earth for hibernation.

Owing to the large size of the beetles and their habits of congregating in immense numbers they are often the occasion of considerable alarm, and very frequent complaints of injury are received and are recorded of them. More often it is apprehension of danger rather than the actual injury which induces the fruit grower or farmer to write for information as to the probabilities of damage.

The beetles have an especial fondness for the ears of ripening corn, particularly sweet corn, and are often accused of boring into the husk to get at the kernels within. Peaches and apples are very subject to attack, and persimmons, tomatoes, and cotton bolls have been reported as being injured.

In some cases, according to Dr. Otto Lugger (Second Annual Rep. Ent., Stat. Expt. Sta. Univ. Minn. for 1896, p. 27), the beetles have eaten off the flowers of apple, plum, strawberry, blackberry, raspberry, and other fruits, and have destroyed the male flowers of corn. Still another form of damage reported by Dr. Lugger is to apples and berries exposed for drying.

The beetles also frequently attract attention through their great numbers on fruit trees and choice shade trees. Often the beetles settle upon the flower heads of golden-rod and thistle, but their occurrence on flowers is not so noticeable as upon fruits.

Messrs. Osborn and Gossard have recorded some interesting observations and the results of experiments to ascertain the possibility of the beetles attacking ears of corn that are uninjured by birds or other insects. Beetles were taken in abundance on *Ambrosia trifida*, to which they appeared to be attracted by the ripening seeds, and confined in different lots with ears of corn, the conclusion being reached that the beetles are capable of entering uninjured ears of corn for the purpose of feeding, but that the habit was exceptional and not liable to occur except in the event of a deficiency of more available and appropriate food. (Bul. 15, Iowa Agr. Expt. Sta., Nov., 1891, pp. 255–258.)

Until recently this species has been known in literature as the Indian cetonia. It has also been called the "bumble flower-beetle" and the "common hairy rose-beetle." In the note by the writer, previously mentioned, the insect for want of a better name was called "brown sap-chafer." It has been a somewhat difficult matter to decide upon an appropriate name. The writer believes that, everything considered, "fruit-chafer" would be more fitting for this class of insects, as it is by their injury to fruits that attention is most often called to them. The name of "brown fruit-chafer" is therefore suggested for the species.

NATURAL ENEMIES.

The larvæ are peculiarly hardy and evidently able to take care of themselves without trouble; still, although their life is so short, they are liable to infestation by the same insect and other enemies which destroy the larvæ of other sorts of white grubs. Of this number is an undetermined species of Tyroglyphus, which was found in a cocoon upon a pupa of the lot reared. Among the notes of Dr. Riley I find mention of a similar instance of the occurrence of Tyroglyphus, found also upon the pupa. The note is dated July 10, 1874.

July 4, 1896, Mr. E. A. Schwarz, of this Division, brought a few larvæ, which were afterwards reared to this beetle, found under a stone at Berkeley Springs, W. Va., with which he noticed several specimens of the larva of a species of Typhia, perhaps *T. ornata*, a well-known hymenopterous enemy of Lachnosterna larvæ. A Typhia larva is also recorded in Dr. Riley's notes as having been observed July 25, 1874, attached to a young larva of this Euphoria.

REMEDIES.

Hand methods are about the only available remedies for the beetles when they occur in sufficient abundance to be troublesome. The use of insecticides on ripening fruit that is soon to be eaten is practically out of the question. During the heat of the day, particularly in the bright sunlight, the beetles are active, but in the shade when feeding they can readily be captured by jarring them from the trees or other plants upon which they occur into bags or nets. A simple screen of mosquito netting applied over drying fruit will afford ample protection against these insects and others liable to be attracted.

Fortunately, the species is one of many that are only periodically numerous enough to be troublesome, and therefore it is not an insect that need often be the cause of serious alarm.

BIOLOGIC NOTES ON THE MAY BEETLE, LACHNOSTERNA ARCUATA SM.

It is a matter of common knowledge that until within the last decade the common white grub of the Northern and Middle States was very generally believed to be the offspring of that species of May or June

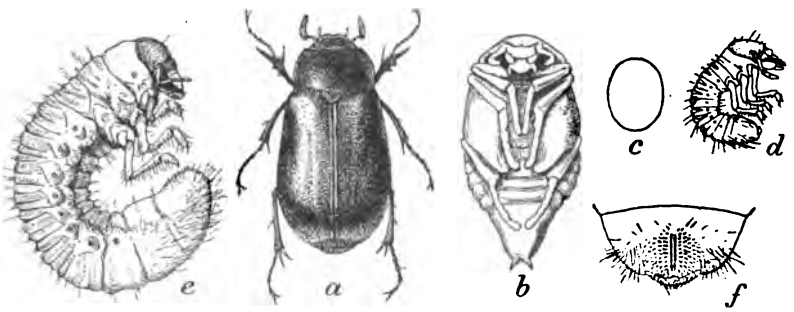


FIG. 16.—*Lachnosterna arcuata:* *a*, beetle; *b*, pupa; *c*, egg; *d*, newly-hatched larva; *e*, mature larva; *f*, anal segment of same from below. *a*, *b*, *e*, enlarged one-fourth; *c*, *d*, *f*, more enlarged (original).

beetle known as *Lachnosterna fusca* Fröhl. About ten years ago, however, chiefly through the studies of Dr. J. B. Smith,[1] it was ascertained that only the common Northern species of white grub belonged to *L. fusca*, while that found most abundantly in the Middle States, and particularly in and about the District of Columbia, was an undescribed species, to which was given the name *arcuata*, from the arcuate process on the penultimate segment of the abdomen of the male beetle. A few years later a very careful and elaborate study of white grubs of certain species of Lachnosterna and of *Cyclocephla immaculata* was carried on at Champaign, Ill., by Dr. S. A. Forbes,[2] official entomologist of that State. Through the researches of the two entomologists mentioned and some others much has been gained that leads toward a more complete knowledge of these insects and their modes of life.

[1] See Insect Life, vol. I, pp. 180–185; Proc. U. S. Nat. Mus., vol. XI, pp. 481–525.
[2] Eighteenth Rep. State Entom. Ill. for 1891 and 1892 (1894), pp. 109–145.

THE ARCUATE MAY BEETLE.

(*Lachnosterna arcuata* Sm.)

Since the publication of Dr. Forbes's reports on these insects the larvæ of our common *L. arcuata* have frequently been sent to this office, and we have been able to identify the species, at least approximately, which, of course, was impossible before that time.

To obtain fresh specimens of the early stages of this species for illustration and study, a number of beetles were captured at the electric lights of Washington City, placed in a jar of earth May 25, 1898, and kept supplied with oak leaves for food. Eggs were not deposited at once, and in fact not until about the beginning of the second week in June, the exact date not having been ascertained. The parent beetles died the following week. The first larvæ hatched on the night of June 23, and eggs were still hatching on the mornings of the 24th and 25th.

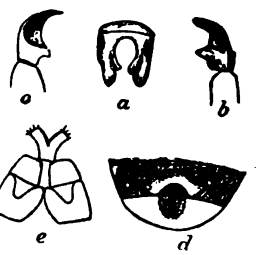


FIG. 17.—*Lachnosterna arcuata: a*, male clasper, from front or above; *b*, right clasper, from side; *c*, left clasper; *d*, ventral characters of male; *e*, genital structure of female—all enlarged (adapted from Smith in Insect Life, VOL. I.)

DESCRIPTIVE.

The following brief descriptions will assist with the illustrations in the recognition of the species in its different stages. It should be remarked, however, that, with the possible exception of that portion of figure 16 lettered *f*, this illustration will apply almost equally well to all or nearly all of the seven species of Lachnosterna, formerly grouped in collections as *fusca*, and now included in what is termed, for convenience, the *fusca* group. The specific differences between *arcuata* and *fusca* are brought out in the illustrations of their sexual characters (figs. 17 and 18).

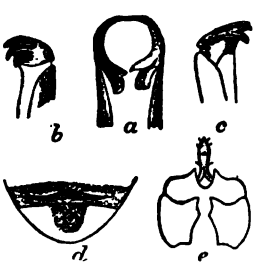


FIG. 18.—*Lachnosterna fusca: a*, male claspers, from front; *b*, right clasper; *c*, left clasper; *d*, ventral characters of male; *e*, genital structure of female—all enlarged (adapted from Smith in Insect Life).

The egg.—The eggs of Lachnosterna are oval when first deposited, but in their growth swell by absorption, as has been pointed out by Dr. Forbes, to a larger size, becoming just before hatching more broadly oval or nearly spherical. The eggs are subject to considerable variation in form and outline. Eggs of *L. arcuata*, just about to hatch, vary in width from 2 to $2\frac{1}{2}$ mm, and in length from $2\frac{1}{2}$ to 3 mm. When newly laid they are nearly white and rather moderately polished, but with their growth they become darker and subopaque. The surface is apparently smooth and without sculpture. In consistency the eggs are quite firm, strong, and elastic. An egg is shown in outline, about three times the natural size, at *c*, fig. 16.

Comparison of the eggs of Lachnosterna of different species with those of Euphoria and Ligyrus shows a very close agreement in shape, color, and general appearance.

The newly-hatched larva.—The larvæ when first hatched have the appearance shown in the illustration at *d*. From the first they rest in the curved position assumed by the embryo in the egg, and when they attempt to move they do so chiefly by crawling in a clumsy manner upon their venters, and not upon their backs as is the case with Allorhina and certain other Scarabæidæ. The newly-hatched larvæ, as would readily be surmised from the variability in the size of the fully developed eggs, vary in size even before they have partaken of food, measuring, if extended, from 6 to 7^{mm} in length and about 2^{mm} across the thoracic segments, which are widest. The head is of course very large in proportion to that of the mature larva, being slightly narrower than the thoracic joints. It is white at first but soon turns to the normal color—dark yellowish. The body is at first entirely white, the yellowish red pubesence or short hairs and the finer and longer hairs of the dorsum showing plainly on the body and toward the extremities of the legs. The mandibles are large and prominent, dark brown in color, becoming nearly black on the inner or cutting surfaces. Larvæ under observation absorbed some nutriment from the earth in which they were confined, which showed in a few hours through the thin skin of the abdomen.

The mature larva.—The full-grown larva differs but little in essential characters from the younger larva, save in the relative proportions of the head and legs to the body proper. It is best described by the figure (see *e*). The absence of a large series of larvæ of other related species renders inadvisable at this time an attempt at specific description. The arrangement of the hairs on the ventral surface of the last or anal segment, as indicated at *f*, presents but little difference between this species and *fusca* as figured by Forbes, which is naturally to be expected when we consider their close relationship.

The pupa.—What is true of the resemblance of the larva of this and related species is even more pronounced in the case of the pupa. No differences between the pupæ of the *fusca* group are known. The pupa of *arcuata*, illustrated at *b*, is of the same white color as the larva.

The beetle.—The beetles can not be separated from those of *fusca*, nor in fact with positive certainty from several other related species, by any tangible and constant characters at present known without examination of the sexual organs or genitalia. The best-marked individuals of *fusca* have the elytra with the longitudinal ridges more strongly defined than is usual in *arcuata*; but this character is so variable as to be of no value whatever for specific identification. The external or corneous portions of the genital organs, particularly of the male, present excellent and constant characters. This will readily be appreciated by anyone who has not already had experience with this genus by a comparison of the male claspers of *arcuata*, shown at *a*, *b*, and *c* of fig. 17, with those of *fusca* at *a*, *b*, and *c* of fig 18, together with the male abdominal and female genital structure delineated by *d* and *e*, respectively, of the same figures.

The color of all the Lachnosternas of this group is shining, dark, mahogany brown, and the thoracic segments on their ventral surface are clothed with fine, long, silky pubescence.

REARING EXPERIMENTS.

May 13, 1893, a course of experiments looking toward the rearing of this species and of other observations concerning its habits, and the remedies to be used against it, was undertaken at this Department, the work being in charge of Mr. Theo. Pergande, from whose notes the following data have been gathered. At this time individuals of both sexes were placed in boxes containing growing grass, the beetles being supplied with oak branches bearing leaves for their food. Egg laying began June 8 and continued for several days. June 19 the eggs began hatching, thus giving a period of at least eleven days. At a subsequent time an egg period was observed to be thirteen days. Observations were continued, with the result that on August 8, 1895, one larva transformed to pupa and on the 31st to the imago, which gives a pupal period of twenty-three days, or a total period of two years and fifty-one days from the time of the laying of the egg until the issuance of the adult beetle, or nearly three years from the time the egg was laid until the appearance of the adult above ground.

INJURIOUS AND OTHER HABITS OF THE LARVA.

Under this heading will be mentioned injury inflicted by both larvæ and adults of *L. arcuata*.

May 18, 1892, specimens of larvæ of this species were received from Mr. H. Harrison, Leesburg, Loudoun County, Va., with report that they were doing great damage to vegetables, shrubs, and other plants in that vicinity.

October 12, 1893, Mr. Pergande found three imagos at depths of between 12 and 18 inches in dry soil, which he described as "almost as hard as rock." December 21 of the same year large numbers of larvæ were found on the Department of Agriculture grounds during the removal of a pile of compost. They were at a depth of about two feet, and were all active and lively at this time, owing, doubtless, to the warmth of the material in which they were living. As has often been observed by those who have had dealings with these creatures, three different sizes of larvæ were found, indicating, as our observations above go to prove, a period of three years for the species.

May 3, 1894, several hundred of these beetles were brought to this office by Mr. D. H. Rhodes, landscape gardener of the national cemetery at Arlington, with the report that the species was doing very serious injury to maple trees that had just been set out in drives and walks about Fort McPherson, which adjoins the cemetery. They were particularly injurious to sugar maple *(Acer saccharum)*. The following year the writer had occasion to visit the same locality about the same season of the year, and then learned that large numbers of

trees had been killed and were being destroyed at that time. Fort McPherson stands at a distance of less than a quarter of a mile from the wooded portion of the cemetery, and is surrounded by freshly plowed and graded grass land, affording the most favorable conditions for the breeding of Lachnosterna. In all there were about 400 trees upon the knoll about the fort. Mr. Rhodes stated that they were first attacked in 1892, and that that year about 200 trees were injured beyond recovery and had to be replaced. The following year injury was such as to necessitate the resetting of 150 trees. The outlook in 1894 was similarly unfavorable. Many of the infested trees showed plainly the ravages of the May beetles, their work being particularly evident toward the tops of certain trees. In very many instances in addition to gouging out portions of the leaves these beetles had amputated the tenderest leaves from the petioles or footstalks. One form of injury particularly noticeable was the gnawing off of the opening leaf buds.

By digging around the soft earth about the base of the worst infested saplings, a considerable number of the beetles were secured. Under one little tree of about two years' growth that was badly defoliated no less than twenty individuals were taken. The beetles were most numerous within a few inches of the base of the tree, and had burrowed beneath the ground to a depth of only a half to an inch in most instances.

June 17, 1896, a number of specimens of the larvæ were received from Mr. B. Clark, Perulack, Va., with the report that the species was destructive to the roots of the grapevine in that vicinity.

In 1897 larvæ were received from the Franklin Davis Nursery, of Baltimore, Md., with the statement, made under date of May 13, that they were very destructive to strawberry plants, cutting frequently from six to ten plants in one place. June 11 a larva was received from Mr. S. H. Derby, Woodside, Del., who stated that the species was doing much damage to the roots of strawberry. July 15 we received another sending of larvæ from the Franklin Davis Nursery Company, all of about two years' growth, with the information that they were playing havoc with strawberry plants. August 5 Hon. George B. Keezell, Keezelltown, Va., sent specimens, with the accompanying statement that they were extremely numerous that year and doing great damage to corn. A letter by the writer in reply, containing a somewhat detailed consideration of the remedial treatment used against "white grubs," was published in the Rockingham Register, of Harrisonburg, Va., for August 27, 1897.

During 1898 the beetles of this species were reported, May 3, to be injurious to young birches in the District of Columbia and to young English walnut trees in the suburbs. May 23 Mr. R. S. Lacey sent specimens, with the information that 110 of the beetles had been captured on a single English walnut on his place near Washington, D. C. They had not troubled either pecans or native walnut trees.

INSECT ENEMIES OF WHITE GRUBS.

Of the insect enemies of white grubs the following parasitic and predaceous species have been observed at this office. Although some of these insects were not observed attacking *L. arcuata*, they are all probable enemies of that species:

Ophion bifoveolatum Say, received July 24, 1890, from Mr. F. M. Webster, Lafayette, Ind., with the report that it had issued from a rearing cage in which he had placed a lot of larvæ of Lachnosterna, probably *fusca*. Dr. Forbes mentions the rearing of the same or a related species under similar circumstances at Champaign, Ill.

Pelecinus polyturator Dru.—Seen in the act of emerging from its pupal envelope, which had been observed in a grub of *L. gibbosa*, at Champaign, Ill., August 25, 1892, as recorded by Dr. Forbes.

Cryptomeigenia theutis Walk.—In and among the dead bodies of adult *L. inversa* a puparium of this tachinid was found at this office October 28, 1892. May 23 of the following year the fly was reared.

Eutrixa masuria Walk. was reared from the adult of *L. arcuata* collected at Washington, the parasite issuing March 12–23, 1895.

Microphthalma disjuncta Wied. issued October 15, 1891, found in the skin of a larva of *L. arcuata* August 12 by Mr. Pergande at Washington.

The three species of Tachinidæ mentioned are all considered, together with their host relations, in Mr. Coquillett's Revision of the Tachinidæ (Tech. ser. No. 7, Div. Ent.), but it is well to bring these data together in connection with the following observations on egg deposit, which occurs on the external surface of living beetles.

At one of the meetings of the Entomological Society of Washington Dr. Howard exhibited specimens of an adult of *L. fusca* captured by him in June, 1897, in Greene County, N. Y., on the thorax of which were glued the eggs of some species of tachinid fly, probably one of the above or a related species. A specimen of *L. inversa* was received from Dr. H. Shaffer, Keokuk, Iowa, on the thorax of which appeared similar eggs. On another species, *L. micans* Knoch., a single egg was discovered, placed on the middle of an elytron near the suture. This last specimen was received from Mr. R. E. Spivey, Sharon, Miss.

Drasterius elegans Fab.(?)—An elaterid larva, presumably of this species, was received August 26, 1897, from Mr. A. Moxcey, Penn Yan, N. Y., with the statement that it had been found fastened by its mandibles to a grub of *L. arcuata*.

Tetramorium cæspitum Linn.—There is also mention in our notes of 17 larvæ of *L. arcuata*, which were being used for experimental purposes, falling prey to the household ant above mentioned, which killed and devoured them.

REMEDIES.

As white grubs pass the greater part of their lives underground, often at a considerable depth, it is obviously a matter of difficulty to reach them with insecticides. Gas lime has been suggested for this purpose, and good results have been obtained against certain forms by the use of bisulphide of carbon, kerosene emulsion, and poisoned baits.

The bisulphide and emulsion remedies are, however, too expensive for employment on a large scale. Of poisoned baits the bran-arsenic mash has been used with success against the white grubs of *Allorhina nitida* by Col. W. Rives, as reported by Dr. L. O. Howard in Bulletin No. 10 (n. s., Div. Ent., pp. 27–28).

Of other remedies are fall plowing, rotation of crops, and the free use of mineral fertilizers, such as nitrate of soda or kainit.

Most domestic as well as many wild animals feed freely upon white grubs, and swine, chickens and turkeys are especially valuable as destroyers of these pests.

In connection with remedies to be employed for the destruction of the grubs, it is also advisable to kill the adult beetles. This may be done by attracting them to strong lights, where they may be gathered and destroyed by crushing or by similar means.

THE SPINACH FLEA-BEETLE.

(*Disonycha xanthomelæna* Dalm.)

A NEW FOOD PLANT.

The unusual abundance in the spring of 1898 of the above-mentioned flea-beetle on the grounds of the Department of Agriculture and elsewhere in the vicinity of the District of Columbia led to its special study, with the resulting discovery of a new food plant and the completion of its life history, already so ably begun by Miss M. E. Murtfeldt while special agent of the Division of Entomology in 1889 (Bul. 22, Div. Ent., pp. 76–78).

Observations began April 16, when a number of the beetles were taken in the vicinity of the leaves of the chickweed, *Stellaria media*, on the lawn of the Department grounds. Subsequently upward of a score of beetles were captured under a board placed for the purpose over a patch of chickweed, and still later larvæ were taken on the same plant and reared to maturity. Oviposition was first observed on the 17th of April, but it probably began somewhat earlier, as this species is one of our first spring visitors, appearing even as far north as central New York as early as the last of March in the first warm days of the season.

The following description of the egg and immature larva will complete our knowledge of the life stages of this species, the mature larva and pupa having previously been described in the article referred to.

DESCRIPTION.

The egg.—The egg is subcylindrical, and regularly elliptical in outline, between two and one-half and three times as long as wide, narrowest toward the apex, where it is subtruncate, widest above the middle, base rounded. Color when newly laid, pale orange buff, changing to somewhat brighter orange later. The surface is rather feebly shining and densely covered with minute pits grouped together so as to form, with the clear spaces between the groups, irregular areas, of which the prevailing pattern is imperfect hexagonal. Between 28 and 31 appears to be the number of rows of areas in the entire length of the egg. Length, 1.25 to 1.50^{mm}; width, 0.40 to 0.57^{mm}.

The group of eggs shown enlarged in the figure at *b* illustrates also the manner of escape of the larva through a hole at one side. The sculpture is shown highly magnified at *c*.

Eggs that came under observation were deposited usually in groups of from 4 to 30, and in one case as high as 50, on the ground and on bits of leaves resting on the earth, all the eggs being placed on end closely but loosely together in the same hexagonal order observed in the arrangement of the areas of the egg, although naturally this order is less regular.

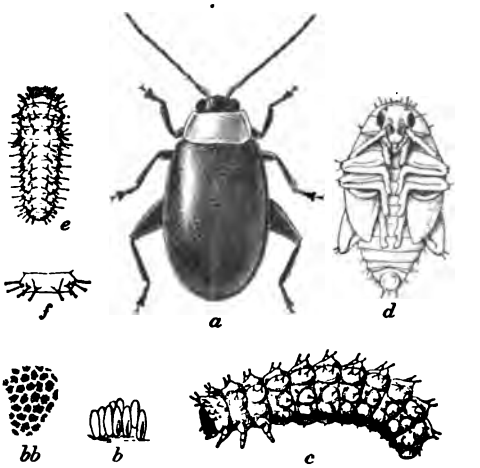


FIG. 19.—*Disonycha xanthomelæna*: *a*, beetle; *b*, egg mass, showing mode of escape of larva at right; *bb*, sculpture of egg; *c*, full grown larva; *d*, pupa; *e*, newly hatched larva; *f*, abdominal segment of same—*a*, *c*, *d*, five times natural size; *b*, *e*, more enlarged; *bb*, *f*, still more enlarged (original).

The larva.—When first hatched, the larva, as may be seen by comparing the figure at *e* with *c*, looks quite unlike the mature form. The tubercles which cover the body are somewhat more conspicuous, the head and legs are much larger in proportion, and the spines (see *f*) protruding from the body are very long, measuring nearly one third that of the body, including the tubercles. The spines are black at the base and nearly white toward their apices, which are capitate, like those of some other species of larvæ in the post embryonic stage. The color is nearly uniform light gray, with a slightly pruinose surface, and the head, eyes, sutures of the legs, and certain other portions are darker. The red of some internal portions can be seen through the anterior portion of the body, the thoracic and first abdominal segments. The length, in the somewhat contracted position which the larva assumes in death, is about 1.80^{mm}; the width, 0.60^{mm}.

The mature larva is figured at *c*. In life it is dull nearly uniform leaden gray in color, with darker head and still darker brown mouth-parts. The length is from 8 to 9mm, and the width 3 to 4mm.

The pupa.—The pupa is of nearly the same color as the larva, being a little lighter. It is well illustrated at *d*.

The beetle.—The adult beetle, shown in the illustration at *a*, is shining black in color, sometimes with a green or bluish luster. The prothorax and abdomen are red in living specimens and reddish yellow in dried material, and portions of the legs and antennæ are pale yellowish. This is not apt to be mistaken for any other common species. From its nearest relative, *D. triangularis*, it differs in the absence of the triangle of spots on the prothorax, and from *mellicollis* by the color of its thorax and legs, those of the latter being bright blue or green and yellow respectively. It measures a little less than a quarter of an inch (5.5mm).

DISTRIBUTION.

The distribution accorded by Dr. Horn, who furnished a more technical description than the above, together with notes, in volume XVI of the Transactions of the American Entomological Society (1889, p. 209), is "from the New England States to Kansas and Florida."

In the collection of the National Museum and that of the writer the species is represented from the following localities:

Fitchburg, Mass., South Woodstock, Conn. (October 20); New York, Ithaca, N. Y.; Newark, Hudson County, and elsewhere in New Jersey; District of Columbia; Jonesville, Fortress Monroe, Rosslyn, Va.; Poolesville and Marshall Hall, Md.; Detroit, Mich.; Kirkwood and elsewhere in Missouri; Nebraska; Kansas; Florida; Columbus, Tex., Bear Paw Mountain, Mont., and Swift Current, British America. It is recorded also from Mount Washington, N. H. (Bowditch); Allegheny, Pa. (Hamilton); Buffalo, N. Y.; Iowa City, Iowa (Wickham), and elsewhere. This includes an area from the Lower Austral through the Transition to the Boreal life zone.

LIFE HISTORY.

Writing of this flea-beetle in her original article, Miss Murtfeldt says:

> This species seems to be but single brooded, as no young larvæ were to be found after the first of June. As, however, the spinach beds were rooted out before midsummer in all the gardens in the vicinity, I can not be quite certain about this point, but could not discover it on beets or any of the native Chenopodiaceæ.

The beetles reared by the writer were kept feeding in confinement, and in time laid eggs, proving that there are two generations produced annually in climates such as that of the District of Columbia.

The duration of the egg stage was observed during hot weather in August. Eggs that were deposited August 11 hatched on the 18th,

and others laid on the 23d produced larvæ on the 30th, giving seven days as the minimum period. It will probably be found that this period in cooler weather will be extended to nine or ten days, according to atmospheric conditions at the time that deposition and hatching takes place, and variation being natural in a species where oviposition practically extends throughout a season. Oviposition was actually observed between April 17 and the first day of June, and again in July, beginning on the 22d, and continuing through that month and August.

The escape of the larva from the egg takes place through a simple longitudinal slit on one side, extending from near the base to the center of the egg. (See fig. 19,*b*.)

Larvæ kept under nearly natural conditions were obliged after hatching to travel 2 inches to the stem of the food plant provided them, a potted Chenopodium, and at least 5 inches farther before reaching a leaf. As the larvæ grow, the social tendency becomes less noticeable, and individuals may be seen here and there on a plant occupying a single leaf. A larva, as a rule, will remain on a leaf until it is full of holes, the sizes of the holes increasing with the growth of the insect. Generally also the larvæ feed on the lower surface of a leaf, but not exclusively.

The gregarious habit of the larva is pronounced from the first. Larvæ which hatched in close quarters in confinement gathered in a group on one side of their rearing dish, and another lot which hatched out on cultivated Chenopodium traveled from one leaf to another, seldom being found singly during the early period of their growth.

One lot of ten larvæ, which was observed to hatch June 8, was kept rather closely confined and fed at first upon chickweed and afterwards upon spinach leaves. June 18, or in ten days from the hatching of the eggs, about half had attained full growth, and on the 20th all but one had entered the earth for pupation. On the 27th two individuals, which we may call Nos. 1 and 2, were found to have pupated. No. 3 pupated June 28 about 4 p. m., and No. 4 transformed about 11 a. m. of June 29. Nos. 1 and 2 were found to have issued as adult July 5, No. 3 died, and No. 4 transformed to a beetle July 5, being still uncolored when first observed at 9 a. m. This last gives us six days as the duration of the pupal state, probably the minimum period, as the weather was extremely hot, the thermometer out of doors having passed the 100° mark during three days of this time. The first two beetles issued during a two days' closing of the office, but it is certain that the date of issuance was July 3.

It is more than probable, judging from the present experience with this species, that the duration of the larval stage varies considerably according to environment. An attempt to rear larvæ, which hatched June 4, on the potted Chenopodium previously mentioned, was not entirely successful, owing to the plant being disturbed. All of the

larvæ were much slower in development, leading a somewhat precarious existence in traveling from one leaf to another and in being compelled to share their food with the aphides which infested the same plant. It required till June 30, or twenty-six days, for one of these to attain maturity, and even at this time it was stunted when it entered the earth. It issued as imago July 12, having required about forty-six or forty-seven days in its development from egg to beetle.

On another occasion a colony of the larvæ of this insect was found feeding on lambsquarter at Rosslyn, Va., June 19, 1893, about half of them at this time nearly full grown. One of the larvæ observed later ceased feeding for a day or two, and July 3 entered the ground, where it remained for several days more before assuming the pupa state. It was still in the larval condition July 7. The imago was formed July 18, but remained in the earth till fully colored and hardened, appearing above ground July 20.

The pupal period in cool weather would probably reach as many as nine days. Thus we would have periods in the life cycle varying as follows: Egg, six to nine days; larva, active period, ten to twenty-six days; inactive period, six to fifteen days; pupa, six to nine days; entire cycle, about thirty to sixty days.

Larvæ were first observed to enter the earth for pupation as early as June 8, to transform to pupæ on the 14th, issuing as adults two weeks later. Individual beetles, presumably of the old or hibernated generation, were observed, though sparingly, as late as July 20, but as the earliest of the first new generation did not appear till the end of the month, there was no overlapping of generations.

The beetles of the first generation, as previously observed, laid eggs for a second generation, beginning July 22, continuing through August until September 5.

By the middle of September nearly all of the beetles of the first generation were dead.

A female with swollen abdomen was isolated August 24. The next morning she had laid a mass of 35 eggs; next day she had deposited another mass of 34; August 30, a third mass of 36; August 31, 38; a fifth September 5, and was still living September 19. She had deposited in this time about 180 eggs, but it is not known how many she may have laid previous to this.

BIOLOGIC LITERATURE.

The biologic literature of this species is limited. In addition to the record quoted there are two others of the occurrence of this species, that published by Mr. Lawrence Bruner in 1891 (Bul. 23, Div. Ent., p. 15), which reads as follows: "Common on beets and other chenopodiaceous plants, the leaves of which it riddles with holes," and that by the writer the following year in which the occurrence of the beetles on *Amarantus spinosus* is recorded (Proc. Ent. Soc. Wash., vol. II, p. 265).

NATURAL ENEMIES.

At least one natural enemy is known for this species. It is the tachina fly, *Hypostena barbata* Coq., which develops within the abdomen of the adult beetle. It was first recorded by the writer as a parasite of this species (l. c., vol. IV, p. 78). June 15 the puparium was found, which had developed from a larva just escaped from a beetle. June 26 the fly issued, having passed eleven days as a puparium.

REMEDIES.

The arsenites are suggested as the rational remedies for this species, the only drawback to their use being the low growth of the plants infested. Paris green with Bordeaux mixture applied to the under and upper surface of the leaves would serve as a remedy for both adults and larvæ. Keeping down the lambsquarter of the vicinity would also prove a measure of value; but this would be a difficult matter with regard to the chickweed.

BIOLOGIC AND OTHER NOTES ON THE FLEA-BEETLES WHICH ATTACK SOLANACEOUS PLANTS.

In continuation of observations begun in 1897 on the biology of the tobacco flea-beetle (*Epitrix parvula* Fab.), and published in Bulletin 10 of the present series (pp. 79–82), the following notes on that and other species of the genus are presented.

THE TOBACCO FLEA-BEETLE.

(*Epitrix parvula* Fab.)

Recent injuries.—July 15, 1898, Mr. Francis Boaler, Huntsville, Madison County, Ark., sent specimens of this species and its work on a leaf of tobacco with the statement that the beetles were destroying tobacco on his plantation. This tobacco was planted on mountain land, sand rock soil, in ground which had been in pasture six years. The land was plowed and then ridged. Our correspondent noticed that the beetles usually stayed on the under surface of the leaves during the daytime and became active about an hour before sundown. They sometimes ate the leaves in such manner as to leave only the ribs and smaller veins. The ground was at this time perfectly free from weeds; but it would seem probable that a large number of solanaceous plants, such as Jamestown weed and nightshade, which we now know to be larval food plants, had grown upon this land or in the immediate vicinity before the tobacco was planted.

Later Mr. Boaler, writing under date of August 10, 1898, stated that the beetles had apparently been destroyed almost totally by heavy and incessant rains. It is not improbable, however, that the weather at this time had driven the beetles into hibernation, perhaps a little prematurely.

July 20 of the same year, in the course of a day's collecting of tobacco insects, Mr. F. C. Pratt found this flea-beetle at College Station, Md., where it was by far the most abundant species, no other insects troubling tobacco in that vicinity. It was reported as slightly injurious the previous year in the same locality (W. G. Johnson, Bul. 9, n. s., Div. Ent., p. 81).

July 29 Mr. T. G. Allen wrote of this species which, in connection with one of the other common species of Epitrix, either *cucumeris* or *fuscula*, was injuring the tobacco at and in the vicinity of Skipwith, Mecklenburg County, Va. He stated that for the past five or six years the crop had been very much damaged by these flea-beetles and that they seemed to increase with every year. They were reported to make their appearance from the middle of July to the first of August, attacking first the bottom and afterwards the upper portions of the plant to the topmost leaves. After they have fed upon a leaf for a while it becomes full of small dry spots and then of holes about the size of a pin point. When the leaf is cured it is poor and thin. At the time of writing he stated that he counted as many as 37 beetles on a single leaf.

The life cycle.—A number of beetles were placed, July 21, upon a potted plant of tobacco that had been kept free from the attacks of this species, which had not at that date, so far as observed, put in an appearance in the vicinity of the Insectary. The potted plant was not examined until August 11, and then two pupæ and one larva were obtained. The larva transformed to pupa August 12 and to imago on the 18th, which gives twenty-eight days as the full life cycle period, presuming upon the deposition of the eggs upon the first day of the experiment, about which there is no reasonable doubt. The weather was very hot during this period.

Eggs were obtained but did not hatch in confinement. The minimum period is probably the same as that ascertained of the pupa, six days, which would afford by deduction a larval period of sixteen days.

The following is a description of the egg:

The egg.—The egg is of about the same length as that of *E. fuscula*, but is narrower and elliptical-ovate instead of elliptical-oval, measuring about two and a half times as long as wide. The color is gray with scarcely a tinge of yellow. Areas similar to *fuscula*, but apparently much more minute, not being visible except under a high magnifying power. Length: 0.40^{mm}; width: 0.18^{mm}.

How and where the egg is deposited in nature remains to be discovered.

Food plants.—We have now ascertained three larval food plants, tobacco, *Solanum nigrum*, and *Datura stramonium*, but it is fairly certain that the larva would thrive on any of the Solanaceæ. The beetles have been observed to feed on *Solanum esculentum* and *carolinense*, and appear to prefer the leaves of the Jamestown weed among weeds, and tobacco among cultivated plants. In our experimental plat in which

grew tobacco, eggplant, and Jamestown weed, potato and tomato did not appear to be attacked at all by this species. In addition to the records of larval rearings given above and in the writer's previous article, it should be mentioned that larvæ and pupæ of this species were taken during the first two weeks of August, and in some numbers, at the roots of *Datura stramonium* at Marshall Hall, Md., and on the grounds of this Department at Washington.

Distribution.—Of the distribution of this species the late Dr. Horn said that it "occurs throughout the entire United States, extending also to the West India Islands." The writer fears that this statement of the distribution is somewhat too comprehensive, as it is well known that it is a southern species, and although it occurs pretty well northward, especially where tobacco is raised, it does not extend as far as the Boreal life zone, and I doubt if it is often found north of the Upper Austral. For the sake of accuracy it may be well to place on record the following list of actual localities from which the species has been recorded or in which it is known to occur:

Chevy Chase, Cabin John, Glen Echo, College Station, Marshall Hall, River View, Poolesville, Md.; Skipwith, Danville, Lynchburg, Woodstock, Rosslyn, Cherry Dale, Va.; District of Columbia; West Virginia; Michigan; Gatewood, Oxford, N. C.; Kentucky; Boyd (injuring tobacco), Columbus (Alwood), Ross County, Ohio; Huntsville, Ark.; Denver, Colo.; Galiuro Mountains, Mont., Chiricahua Mountains, Tucson, and elsewhere in Arizona; Cypress Mills and Burnett County, Tex.; Haulover, Capron, New Smyrna, and elsewhere in Florida, and Montserrat, W. I.

It is also recorded from the Bahama Islands; Guatemala; Panama (Champion); Mexico; and Cuba (Crotch).

The above statement of localities indicates this species to be Austral and Tropical. As further corroborating the stated belief that it seldom if ever occurs above the Upper Austral zone it should be said that the species is not represented in Dr. Hamilton's list of the Coleoptera of southwestern Pennsylvania, and does not to the writer's knowledge occur in the State of New York.

A parasitic enemy.—This flea-beetle, as well as *E. cucumeris*, is parasitized while in the adult condition by what is evidently, judging by the larvæ, a species of the hymenopterous family Braconidæ. Numbers of beetles were collected in order to rear the parasite. Larvæ were first observed July 14, but none lived more than a few days after issuing from the beetles. All of the parasitic larvæ, as far as could be learned, made their escape from an aperture made at the anal orifice of their host.

THE EGGPLANT FLEA-BEETLE.

(*Epitrix fuscula* Cr.)

This flea-beetle was observed during the season of 1898, May 17, in hothouse frames of eggplant at Tennallytown, D. C. May 21 great numbers, as many as eight or ten to a small plant no higher than 3 or 4 inches, were observed on horse nettle at River View, Md. All these

plants were much eaten and had evidently been attacked as early as the first week of May, or soon after their first appearance above ground.

Eggs were laid freely overnight, and the following description was made:

The egg.—Elliptical-oval, a little less than twice as long as wide; moderately shining, yellowish gray; surface divided into very minute irregular areas, somewhat symmetrically, but not always regularly, disposed in groups of seven inclosed in hexagons. Length, 0.40 to 0.42^{mm}; width, 0.22 to 0.24^{mm}.

This flea-beetle has received little attention at the hands of economic entomologists, for the obvious reason that it has without doubt been very generally assumed to be identical with the very similar *E. cucumeris*. In our official correspondence it has been reported as injurious but once, and that during the past year. August 3 and 9 Mr. Henry J. Gerling sent specimens of the beetles which were attacking the leaves of eggplant at St. Charles, Mo., the foliage being described as badly eaten.

In a paper entitled "Supplementary report on insects affecting the strawberry," published by Prof. S. A. Forbes in the Transactions of the Mississippi Valley Horticultural Society for the year 1884 (vol. II, p. 236), this species, mentioned as *Crepidodera fuscula*, is included in a list of flea-beetles that infest the strawberry. No particulars, however, are given beyond a brief description of the adult. The same paragraph on flea-beetles affecting strawberries appears in the same writer's annual report as State entomologist of Illinois for the year 1883 (1884, p. 86).

The first account of any length which I find concerning this insect is given by Prof. H. Garman in the Second Annual Report of the Kentucky Agricultural Experiment Station (1890, p. 26), where the species is mentioned under the title, "The Potato Flea-beetle, *Crepidodera fuscula* Crotch." The statement is made: "Wherever examined last season the potato leaves were found to be gnawed full of small holes, which, from their abundance and from the fact that the edges of the holes became brown after a time, often gave the leaves a diseased brown appearance." In several fields examined it was impossible to find a leaf entirely free from injury. Nothing of the life history of the species was ascertained, but it was found "that a mixture of lime, sulphate of copper, and water saved the potato from the injuries of this flea-beetle very effectually."

The same writer under the heading "Bordeaux mixture as an insecticide" (Agricultural Science, vol. VI, p. 126, 1892), again commented upon the efficacy of a spray of Bordeaux mixture as a remedy against this flea-beetle (mentioned as *Crepidodera pubescens*).

Mr. Garman also gives a short account of this species under the title "The Southern Flea-beetle of Potatoes, *Epitrix fuscula*," in Bulletin 61 of the Kentucky Agricultural Experiment Station, published in 1896 (pp. 15, 16). The ravages of this flea-beetle were observed to be checked by a combination of Paris green and Bordeaux mixture, or by the former applied alone.

The above summarizes practically all that has been published on this species, at least in its economic or biological aspect.

Of its distribution Dr. Horn was at fault in stating that it "seems to be a widely distributed species over the entire country east of the Mississippi, also in Missouri." It appears to have very much the same distribution as the congeneric *parvula*. According to Mr. Charles Liebeck, it is generally distributed, though rare, in New Jersey. It does not occur in New York State to my knowledge.

In the neighborhood of the District of Columbia it is rather more abundant than either *parvula* or *cucumeris*, and although it probably infests all the Solanaceæ, it shows in the writer's experience, a marked fondness for eggplant when this can be obtained, hence the name "eggplant flea beetle," which is here proposed. It is also common on potato, but rather rare on tobacco. I have not found it at all on tomato.

The following list of recorded localities is from specimens in the National Museum and in local collections, or from published records: New Jersey; River View, Marshall Hall, Cabin John, Md.; Tennallytown, Washington, D. C.; Rosslyn, Cherry Dale, Pennington Gap, Va.; Round Knob, N. C.; Marietta, Ohio; Kentucky; Illinois; St. Charles, St. Louis, Mo.; Savannah, Ga.; Bayou Sara, La.; Jackson, Miss.; Nebraska; Kansas; Columbus, Tex.; Los Angeles, Sonoma, and Pomona, Cal.

It is doubtfully recorded from Guanajuato, Mexico (Jacoby).

THE CUCUMBER FLEA-BEETLE.

(*Epitrix cucumeris* Harr.)

Owing to the scarcity of material at the time when and in the places where sought, nothing of interest was gained from personal experience with this insect the past year. It is desirable, however, to place on record the following facts concerning it, gleaned from one of our correspondents, Mr. C. Cronk, New Hamburg, N. Y.:

FIG. 20.—*Epitrix cucumeris*: adult beetle, much enlarged (original).

July 22, 1898, he wrote that the beetles and their larvæ were very destructive to tomatoes in his vicinity. In response to a request for larvæ our correspondent sent, under date of August 5, two minute larvæ taken from about the roots of tomato. Although when they were received they were not in fit condition for study, there was no doubt as to their identity, as this is the only flea-beetle of the genus Epitrix which is positively known to occur in that latitude, or, in fact, in any portion of New York State.

Adult beetles collected near Washington were parasitized, evidently by the same species mentioned as preying upon *E. parvula*.

"Cucumber flea beetle" is an obvious misnomer, as anyone knows who has studied the habits of the genus Epitrix. The present species, *cucumeris*, so far as we are able to judge, would not live in the larval condition on any other plant than those of the botanical order Solana-

ceæ, and the adults, although inclined to be omnivorous at times, are practically confined to this order of plants when such are available.

The beetle is illustrated in the accompanying figure.

OTHER SPECIES OF EPITRIX.

Of the remaining species of Epitrix, *E. brevis* Sz. has been found by its describer on *Solanum nigrum*. It closely resembles *cucumeris* in color and in its comparatively sparsely punctate thorax. It differs chiefly in its shorter form and feeble antebasal thoracic impressions. It is evidently rare, being recorded only from Enterprise, Fla., and Columbus, Tex.

The larval habits of *E. lobata* Cr., which is known from North Carolina and Florida, and *E. subcrinita* Lec., which inhabits Oregon, California, Nevada, Utah, and Arizona, are unknown. Both probably feed in their larval stages on Solanaceæ; the latter with little doubt does so, as it has been reported to injure young tomato plants, while in the beetle condition it also injures beans. (Insect Life, vol. IV, p. 135.)

REMEDIAL TREATMENT.

In addition to the remedies mentioned as of value against the tobacco flea-beetle (Bul. 10, n. s., p. 82), namely, pyrethrum mixed with flour or road dust, Bordeaux mixture, and Paris green, combined or alone, it has been suggested by Dr. Howard that the destruction of weeds of the family Solanaceæ around the margins of fields and gardens will result in positive benefit in the reduction of the numbers of these flea-beetles as well as of numerous other insects which infest solanaceous crop plants. He suggests, also, the growing of a few clumps of jimson weed or nightshade as trap crops for the beetles, the plants to be thoroughly poisoned in the early summer before the crops are planted or set out. This matter will be treated somewhat at length in a forthcoming article by Dr. Howard, entitled "The principal insects affecting the tobacco plant," in the Yearbook of this Department for 1898. If this is done, and the writer is of the opinion that the jimson weed is the preferable plant, owing to its larger size and apparent greater attractiveness to the flea-beetles as well as other solanaceous feeders, the precaution should be observed to destroy them before seeding time, that they may not prove a pest rather than a benefit.

THE CHERRY LEAF-BEETLE.

(*Galerucella cavicollis* Lec.)

RECENT INJURY.

June 4, 1898, Mr. P. W. Hombach, St. Ignace, Mackinac County, Mich., wrote that this species, specimens of which were inclosed, was found in great numbers on cherry trees, eating holes in the leaves.

Through the kindness of Dr. Sylvester D. Judd, of the Biological Survey of the Department of Agriculture, specimens of the above

mentioned species were received from Mr. M. S. Haslett, who wrote under date of June 5 that this insect was infesting and doing considerable damage to the foliage of young peach trees at Spruce Creek, Huntington County, Pa.

Four days later Mr. Charles A. Heilman wrote from Lebanon, Lebanon County, Pa., sending specimens of the beetle with the statement that they were found abundantly on peach trees, the leaves of which they injure by pitting them full of small holes. Our correspondent had been through a peach orchard 3 miles west of his town and had found only one of the beetles, while in the town the beetles were to be seen by thousands on single trees during the two days previous to his writing.

The past year it was injurious to cherry trees at Corning, N. Y., as reported by Mr. E. P. Felt (Bul. N. Y. St. Mus., vol. V, p. 235; Bul. 17, n. s., Div. Ent., p. 20), and was said by Dr. J. B. Smith to have been found on peach trees in Pennsylvania (l. c., p. 23).

OTHER RECORDS: FOOD HABITS.

The cherry leaf beetle was first noticed causing damage to cultivated cherry trees in 1894 at Bellaire, Mich. (G. C. Davis, Insect Life, vol. VII, p. 200.) The following year it attacked the foliage of cherry trees at Ausable Forks, N. Y. (Lintner, 11th Report, Insects of New York, pp. 197, 198.)

A short illustrated account of this insect is given by Mr. R. H. Pettit in a bulletin entitled Some Insects of the Year in 1897. (Bul. 160, Mich. St. Ag. Coll. Expt. Sta., p. 427.) Specific mention is not made of attack committed that year, but the title would imply that such injury had been noted. In the original case of injury reported, the presence of the insect was also noted on wild cherry in the immedate vicinity.

In the Third Annual Report of the Pennsylvania Department of Agriculture, Division of Forestry, for 1897 (1898), pp. 106, 107, Mr. Charles W. Johnson gives a short account of this species. He says: "Myriads of this beetle and its larvæ were observed during the first week of September devouring the leaves of the 'fire cherry' (*Prunus pennsylvanica*) at Ricketts, Wyoming County, Pa."

There is little doubt that the species described under the name of *Galeruca sanguinea* in Dr. Packard's Fifth Report on Insects Injurious to Forest and Shade Trees (p. 529) as attacking wild cherry is in reality *Galerucella cavicollis*, as has already been stated. (Insect Life, vol. IV, p. 94.) The species is also mentioned by Dr. Hamilton as occurring on Prunus. (Trans. Amer. Ent. Soc., vol. XXII, p. 371.)

The injurious occurrences are of interest as examples of the change of habit of a species of insect from a wild to a cultivated plant of the same genus (Prunus), and from this to a cultivated plant of a closely related genus (Amygdalus). Until 1894 it will be noted no other food plant of the species other than wild cherry was known, and until the

past season peach was unknown as a host plant. That it prefers the cultivated to the wild plant appears to be assured by recent observations, and there seems little doubt that as fruit growers become more familiar with entomology more instances of injury will come to light.

The beetles are recorded to feed in June and September, the first beetles seen representing the hibernated generation; those appearing in the fall consisting of their progeny, since there is little doubt that the species is single brooded. It is probable, judging from the date of our correspondence, that the beetles appear sometimes in May in their southern range and continue until July at least in more northern localities, since beetles were observed by Dr. Lintner's correspondent as late as July 10.

The reported occurrence of the species on chestnut is hardly of sufficient value to carry much weight as the statement quoted by Lintner from one of his correspondents was not supported by specimens.

Wild cherry it seems probable is a natural food plant. Larvæ are known to occur on cherry and probably also feed on peach leaves, but were not said to do so by our correspondents.

DESCRIPTION AND DISTRIBUTION.

This species, as its generic name indicates, is a near relative of the imported elm leaf beetle. It is smaller than the latter, measuring less than one-quarter of an inch in length (4.5 to 5.5^{mm}); is bright red in color, with the antennæ, eyes, and the exterior portion of the legs black. From *G. rufosanguinea*, which this species very closely resembles, it may be distinguished by its coarser punctuation, the punctures with distinct intervals and its more shining surface. It was first described by LeConte in 1865 (Proc. Acad. Nat. Sci. Phila., 1865, p. 216) under the genus Galeruca, and afterwards and until recently was classified under Adimonia. A technical description will also be found in Dr. Horn's paper on the Galerucini of Boreal America (Trans. Am. Ent. Soc., vol. xx, p. 76), published in 1893. It is there stated to occur from Canada to the New England and Middle States westward to Wisconsin, and is stated on the authority of LeConte to be found also in North Carolina, the type locality. The following list includes more exact localities from recorded notes and from specimens in the National Museum and other local collections: Berlin Falls, Mount Washington, Mount Adams, N. H.; Cambridge, Mansfield, Mass.; Corning, Ithaca, Ausable Forks, Catskill, N. Y.; Hartford, Conn.; Spruce Creek, Lebanon, Ricketts, Allegheny (vicinity), and elsewhere in Pennsylvania; Woodstock, Va. (Pratt); St. Ignace, Bellaire, Mich.; Texas; Vancouver, B. C.

From beetles received from Mr. Heilman June 15 eggs were obtained from which the following description has been drawn:

The egg.—The egg at first sight is wholly unlike that of the congeneric imported elm leaf-beetle (*G. luteola*), being of an entirely different form.

It is oval, of somewhat variable proportions, the width being about five-sixths of the length. Color bright stramineous. Surface deeply pitted with minute, deep and distinct, rather irregular hexagonal areas, symmetrically arranged in sevens, inclosed within a hexagonal area. Length, 0.65 to 0.70^{mm}; width, 0.50 to 0.60^{mm}.

The first egg hatched June 26, eleven days from the date of laying, a period a day or two longer perhaps than normal.

The following description of the larva was made by Mr. Davis from specimens received July 10:

The larva.—About 5^{mm} long, not very broad, and tapering posteriorly. Head, legs, pronotum, and terminal plate black in all the specimens except one which was larger, and these parts in that one are reddish brown. On the dorsum of each segment are two transverse rectangular parallel dark spots, with two or more smaller ones on the sides at the end of the large ones, and beneath these is a longitudinal block on each segment. The venter of each abdominal segment is marked with five dark-brown spots, the central one being largest.

REMEDIES.

An efficient remedy for the cherry leaf-beetle will be found in the use of an arsenical spray, as described for use against the congeneric imported elm leaf-beetle (see Circular No. 8, 2d ser., Div. Ent., pp. 3 and 4).

NOTES ON THE PLUM AND THE ROSE LEAF-BEETLES.

THE PLUM LEAF-BEETLE.

(*Nodonota tristis* Ol.)

During the first week of July, 1897, this leaf-beetle was observed at Colonial Beach, Va., in considerable abundance, devouring the leaves of plum trees, particularly young plants that were already suffering from the ravages of the pear slug, *Eriocampoides limacina* Retz. (*Selandria cerasi* Peck.). The beetles were also observed in nearly equal abundance on the foliage of the peach, and in less numbers devouring the leaves of apple. They occurred still less abundantly on cherry and choke-cherry (*Amelanchier canadensis*). Wild roses, which are the favorite food plant of the congeneric *N. puncticollis*, were still in bloom at this time, but were not attractive to the insects. A few beetles were beaten from blackberry and dewberry bushes and from wild grapevine, but it could not be ascertained if they were feeding on these plants. By the third week in July the beetles had disappeared at this place. August 2, however, a single straggler was picked up at Marshall Hall, Md. The earliest appearance of the beetle noted was at the latter locality June 18, 1898.

A search through the biologic material in the National Museum collection shows that the species mentioned by Dr. Riley in the report of this Department for 1884 (p. 336) as "*Colaspis tristis*" is in all probability *Nodonota tristis*, as there are specimens in this collection labeled

"on willow," from central Missouri. There is in the same series a specimen from Mr. P. Pedersen, collected at Huntingdon Valley, Pa., on peach, and a series also taken by Mr. W. H. Ashmead at Utica, Miss., in August, with the note that the beetles, together with two other species of Chrysomelidæ, "gnaw little irregular holes through the outer covering of the blossoms, and frequently gnaw into the epidermis of the bolls, thus exposing them to the weather and causing them to drop." (Insect Life, vol. VII, p. 247.)

The species mentioned by Walsh in volume I of the American Entomologist (p. 12) under the name of "*Colaspis*, n. sp.?," described as "a roundish leaf-beetle, about one-eighth inch long, generally of a steel-blue color, but occasionally verging upon brassy brown," and which was beaten from the plum at Alton, Ill., June 19, will now, I think, be considered to be not *puncticollis*, but the true *tristis*.

The name "plum leaf-beetle" is proposed for this species to distinguish it from *puncticollis*, the rose leaf-beetle.

From *puncticollis* this species is to be distinguished by its much shorter, oval form, simple punctation of the thorax, and the absence of a post-umbonal costa. The prevailing color of beetles taken in Virginia and farther north is shining dark metallic blue, with the legs and antennæ yellow or castaneous. The same colors are represented in individuals from the Southern States, with the addition of a number of variations of the dorsal surface, which include metallic green, bronze, purplish and very dark brown.

Dr. Horn credits this species with a distribution "from the Middle States to Kansas, southward to North Carolina." In the National Museum collection and that of the writer are specimens from Fitchburg, Mass.; Detroit, Grand Lodge, Mich.; Washington, D. C.; Marshall Hall, Riverside, Md.; Colonial Beach, Rosslyn (June 26), Pennington Gap, Va.; Fort Pendleton, W. Va.; Round Knob, Retreat, N. C.; central Missouri; Huntingdon Valley, Pa.; Shreveport, La.; Cypress Mills, Dallas, Columbus, Tex. (May 18 to July 5), La Veta, Colo. and Arizona. It will be seen that it inhabits alike the Upper and Lower Austral life zones.

Undoubtedly the larvæ live, like other Eumolpini, upon roots, and it is probable that they may be found upon the rootlets of plum and other fruit trees. The beetles, it was noticed, have a habit of concealing themselves in the folds of leaves.

During July of 1897 many beetles were kept confined with leaves of peach, upon which they fed freely; but no eggs were deposited, and nothing whatever was positively learned of the early life economy of the species.

In 1898 the same negative experience was had with a lot of beetles until July 16, when three of them—the only ones left—were isolated, with the result that a mass of 36 eggs was obtained, laid side by side in the fold of a leaf and in irregular rows, in the same manner as observed with certain other Eumolpini when in confinement.

The egg.—The egg is elongate ovate, one side sometimes strongly curved, the opposite with a tendency to straightness except toward the ends. Color, shining dirty whitish gray, not yellowish; surface without sculpture. Length, 0.75 to 0.84^{mm}; width, 0.32 to 0.34^{mm}.

Eggs that were deposited July 18 hatched on the 25th, giving a period of seven days, which represents nearly the minimum, as the temperature averaged about 86° F. at this time.

THE ROSE LEAF-BEETLE.

(*Nodonota punctticollis* Say.)

June 4, 1897, Mr. Robert McLean, Baltimore, Md., sent specimens of this species which he reported to be "causing some destruction to several trees" in his garden in the country near there. The beetles were said to be "consuming all the leaves from the trees." No particular trees were specified, but they were presumably fruit trees.

This insect was also injurious in at least one locality that year near Washington. It was stated by the late Mr. G. H. Hicks to be very troublesome on roses at Kensington, Md.

June 4, 1898, beetles were found in abundance on the young terminal leaves of ornamental willow at Tennallytown, D. C., being at this time more numerous on this tree than upon blackberry in the immediate vicinity.

Previous efforts to obtain the eggs of this genus, as already mentioned, failed in spite of the best conditions that could be secured.

June 9 Mr. F. C. Pratt obtained, at the writer's request, a large series of this species on the occasion of a trip to Woodstock, Va., from which eggs were secured later. It was extremely abundant at that place on blackberry as well as on wild rose.

Eggs were deposited June 12, in one instance in a mass of 19, placed side by side in the same manner as in *N. tristis*. From the eggs of that species they differed in no observable way. The average measurement was 0.80^{mm} long and 0.30^{mm} wide.

Among the beetles received from Woodstock, Va., one was noted on the under surface of which was a larval mite which has been identified by Mr. Nathan Banks as *Eupalpus echinatus* Bks.

REMEDIES.

These leaf-beetles are amenable to the same treatment as the cherry leaf-beetle and imported elm leaf-beetle. As they do not fly quickly, it is easy to capture them by jarring them onto inverted umbrellas or other similar specially prepared appliances saturated with kerosene.

NOTE.—*Nodonota clypealis* Horn has been noticed in July and early August in great abundance in Maryland near the District line on the fresh terminal leaves of *Actinomeris squarrosa* growing on high land as well as on *Ambrosia trifida* on river bottoms, as previously reported.

NOTES ON THE FRUIT-TREE BARK-BEETLE AND OTHER BORERS AFFECTING FRUIT TREES.

Since the publication of Circular No. 29, second series, on the fruit-tree bark-beetle (*Scolytus rugulosus* Ratz.), a few notes have been gathered from correspondence and from personal observation which will be here recorded.

These notes corroborate statements made in the circular in regard to the parent beetles choosing diseased trees by preference for oviposition, as also statements that beetles will attack healthy trees, add some new food plants to the known list already published, and demonstrate the efficacy of kerosene when rubbed upon infested trunks and branches as a remedy for the beetles. Certain other facts are also mentioned.

Certain other fruit-tree borers have also come under observation and will be briefly mentioned.

THE FRUIT-TREE BARK-BEETLE.

(*Scolytus rugulosus* Ratz.)

May 16, 1898, Prof. E. A. Popenoe wrote from Topeka, Kans., that in a search for trees attacked by this species in different portions of Kansas many rows of trees were examined, and in nearly every tree affected the top was blighted or a stump remained whence a blighted branch had been cut. Beetles were also noticed in pear trees whose leaves were colored so as to indicate ill health and were found to be also diseased at the root below the budding point. Many of the diseased trees showed the beetles just beginning work, precluding the possibility of the appearance of disease resulting from the beetle attack. The conclusion was reached that the diseased trees were preferred by the Scolytus as a place of oviposition. In a few trees, however, the beetles were found at work where there was no sign whatever of ill health in the tree attacked, thus corroborating statements of like nature previously made by the writer.

Mr. Ernest Walker, of Clemson College, S. C., wrote May 18 that this species was doing damage on *Prunus simini* and Japanese plums.

Mr. J. C. Andrus, Manchester, Scott County, Ill., stated in a letter dated May 15 that in his experience this species attacks mountain ash and Juneberry (*Amelanchier canadensis*), both new food plants for this country, and the latter unrecorded.

In response to inquiry in regard to remedies, Mr. C. C. Beals, of New London, Howard County, Ind., wrote under date of August 23 that this insect made its appearance at that place about the middle of July, peppering the bark of the cherry trees with holes and running about over the bark. In two or three days after the first noticed appearance a tree was sprayed with kerosene, but this had no apparent effect. The kerosene was then rubbed upon the trunk and larger branches

with the result that all the beetles were killed. At the time of writing the tree was doing well. Writing again October 25, Mr. Beals stated that although the kerosene killed all the insects with which it came in contact, the experiment was not an entire success for the reason that the smaller branches and twigs were not treated.

As still further corroboration of the statements previously made, that this species will attack healthy trees, the writer observed during the season of 1898 in the same orchard mentioned in the footnote on page 3 of the circular, a perfectly healthy apple tree, which had been attacked evidently several years previously, judging from the nearly obsolete scars on the trunk. Specimens of the beetle, dead in two or three of the burrows, showed beyond doubt that this was the species concerned, were it possible to mistake its work for that of any other known Scolytid. The apple tree had entirely recovered from attack.

The peach tree mentioned in the same footnote as apparently perfectly sound except for the attack of the beetles was again attacked last fall, and will be kept under observation, as it is probable that it will not be able to survive more than one or two years under the circumstances. The particular place selected by the beetles for their principal attack in 1897 showed the presence of "sun scald" early in the succeeding summer. Later this space, which was on the main part of the trunk, was found to be badly infested with the peach borer (*Sannina exitiosa*). Some of the smaller branches had attracted another well-known borer of the peach, *Phlœotribus liminaris* Harr., and the tree now shows the effect of attack, although no beetles have yet bred from any except one dead branch.

The presence of this bark-beetle in trees infested by the San Jose scale, as mentioned on page 2 of the circular, was again noticed the present year, but Messrs. W. G. Johnson and F. M. Webster have both informed me that this is unusual.

Chiropachys colon Linn., the most abundant and destructive parasitic enemy of this bark-beetle, was noticed abroad the past year as early as April 9.

THE BANDED HICKORY BORER.

(*Chion cinctus* Dru.)

A Cerambycid larva, unknown to the writer, was observed at Colonial Beach, Va., in 1897, at work in branches of plum infested also by *Scolytus rugulosus*. It was reared, and proved to be *Chion cinctus*. This is, I believe, the first instance of this species being found attacking orchard trees. Among divisional notes it is recorded that larvæ were received at this Department in September, 1880, from Mr. J. T. de Jarnett, Eatonton, Putnam County, Ga., with the report that the species was doing damage to all kinds of oaks.

THE GRAPE CANE-BORER.

(*Amphicerus bicaudatus* Say.)

This well-known species, which is also called the apple twig-borer, has recently come to the front as an enemy of stored lumber, and, although only a single instance of injury appears to be known, the character of the damage, owing to the large size of the insect and the length of its burrows, is most striking, and sufficient to stigmatize this beetle as one of the foremost of troublesome species when once it obtains access to a lumber yard.

August 27, 1897, Mr. W. A. Wimsatt, of Washington City, brought to this office specimens of the beetles, with the report that they were injuring ash wood in his lumber yard. He later brought, by request, a small board in which the beetles were boring. In a space in this board 3¾ inches long by five-eighths of an inch wide no less than 11 burrows of this beetle appeared. In two instances a beetle had excavated a burrow partly within one board and partly in another, injuring both. One beetle was still alive and active in one piece as late as November 15, and the following spring half a dozen more beetles issued. Neither larvæ nor pupæ were found, and it is uncertain as to whether or not the beetles which issued from the wood bred therefrom.

Mr. Thomas A. Williams, of the Division of Agrostology of this Department, and an entomologist of some experience, informs me that in the winter of 1892–93 he received from a farmer in the northern part of South Dakota some twigs of apple and green ash (*Fraxinus viridis*) showing the characteristic borings of this insect, and also some of the mature beetles which had been taken in the holes. To be positive that the same insect was working in both plants Mr. Williams wrote for more material, to be sent in separate packages, as well as for data regarding the extent of injury in each case. In the second lot of material which he received, an abundance of borers were found, and he satisfied himself as to the identity of the insect in each case. The borers worked in the ash in exactly the same manner as in the apple. According to the farmer the insects first appeared in a small apple orchard, and after practically ruining the trees transferred their attention to the green ash on his tree claim, and did a great deal of damage. The twigs sent were very badly infested, showing evidence of the presence of great numbers of the insect. During the years mentioned, as also in 1894 and to a less extent in 1895, borers of the same kind did a great deal of damage in the Northwest, the conditions being evidently favorable for their increase, drought lessening the vitality of the trees and rendering them more susceptible to the ravages of the insect.

THE EYE-SPOTTED APPLE-TWIG BORER.

(*Oberea ocellata* Hald.)

Since the first recorded injury by this species to fruit trees, in an article by Miss M. E. Murtfeldt, in the report of this Department for the year 1888 (pp. 137, 138), the insect has attracted more or less attention by its occurrence on fruit trees, and has been the subject of cor-

respondence every year or two. Singularly enough, however, nothing seems to have been published concerning it except in the article referred to, although mention has been made of this, or what is probably this, species in at least one other publication.

During the season of 1898 we received specimens from Mr. G. A. Schattenberg, Boerne, Tex., with the report that the species was found in great abundance in the tips of branches of peach and plum trees. It had never occurred in pear there and seldom in apple. It was also received from Mr. G. Hillje, from Delhi and String Prairie, Tex., with report that it was injurious to peach trees in the first-mentioned locality and to peach and plum near the latter place.

Larvæ of what appeared to be the same insect were received from Mr. W. B. K. Johnson, Allentown, Pa., where they were found in the small limbs of apple. It is not positively known if this species is injurious so far North as Allentown, hence we are anxious to obtain material from Northern localities, that the species may be reared to the adult.

From earlier correspondence it appears that this species affects, in addition to apple, peach and plum, pear and poison sumac.

REMEDIES.

Nothing new has developed in the line of remedial treatment to be observed against any of these borers. Opportunity has been afforded for the testing of bisulphide of carbon against one species of borer, and the matter will receive mention in some future publication of this Division.

BULLETIN NO. 23—NEW SERIES.

U. S. DEPARTMENT OF AGRICULTURE,

DIVISION OF ENTOMOLOGY.

SOME INSECTS

INJURIOUS TO GARDEN CROPS.

A SERIES OF ARTICLES DEALING WITH INSECTS OF THIS CLASS.

PREPARED UNDER THE DIRECTION OF THE ENTOMOLOGIST,

BY

F. H. CHITTENDEN,

ASSISTANT ENTOMOLOGIST.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1900.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF ENTOMOLOGY,
Washington, D. C., February 17, 1900.

SIR: I have the honor to transmit herewith a manuscript containing a series of articles dealing with the subject of insects injurious to garden crops, prepared by Mr. F. H. Chittenden, of this Division. Similar articles, by the same writer, have been published from time to time in Bulletins Nos. 10 and 19, new series, of this Division, also in various circulars, and in the Yearbooks of the Department for 1896 and 1898. The general subject has been under investigation for several years with the plan of publishing, ultimately, a complete volume on the garden insects of the United States for the practical use of truck farmers and gardeners. The articles which have been published and these which are presented have been prepared (where not preliminary or supplementary to more complete accounts) in detail, giving the complete history, as far as is known, of each species treated, a work which involves a great amount of original study, and which is published in full as a matter of record and for the use of working economic entomologists as well as of farmers. It is planned, however, in the completed report to condense all of this matter into an easily understood and practical working form. I recommend the publication of this group of articles as Bulletin No. 23, new series, of this Division.

Respectfully,

L. O. HOWARD,
Entomologist.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

ILLUSTRATIONS.

PREFACE.

The series of articles here presented in bulletin form under the title "Some insects injurious to garden crops," is in continuation of work done by the writer in previous years on the same subject, the results of which have been announced in different publications of this Department, and are for the most part based upon observations which have been made during the year 1899, although many of the species treated were under more or less continuous observation prior to that time.

Some of the species of insects which are considered are more or less spasmodic or sporadic in the nature of their attack and injurious only in seasons which have been unusually favorable to their increase. A certain proportion of these are for this reason of secondary importance, economically speaking, since in ordinary years of comparative scarcity they find nutriment sufficient for their needs in various wild plants and weeds, being driven to attack cultivated or other useful plants only in their seasons of greatest abundance. Some few of these are as yet comparatively little known, having done no material damage, but several are increasing in noxiousness and those which have never assumed great importance are liable to become so at any time, at least periodically or locally. Certain of the species under consideration, however, are of the highest economic importance when they occur in excessive numbers, and two of these, the destructive green pea louse and the fall army worm, have been among the most troublesome pests of the past year.

As in the case of previous general articles on insects affecting garden and orchard crops, the writer has endeavored to treat each species in all its relations, descriptive, historical, biologic, and economic. An effort has also been made to furnish not alone lists of exact localities in which each species has been captured or observed at work, but to define as nearly as possible from these data its geographic range, whether an inhabitant of this or that life area, and whether the natural range has been extended by a corresponding increase in the cultivation of its food plants and by commerce.

A series of investigations on certain species of insects which attack cruciferous and cucurbit crops was planned for the season, but was necessarily postponed on account of the scarcity of the insects them-

selves, due in great part to atmospheric conditions during the winter of 1898–99, which materially interfered with their hibernation, as already explained in an article by the writer in Bulletin No. 22, pages 51–64. A few cruciferous pests, however, came under observation, and two species were given special study.

Observations on insects which affect beans and peas have been continued, a considerable number of the species here treated being known to attack edible leguminous plants.

One of the most interesting insects of the year from the naturalist's standpoint is a gall-forming vine-borer affecting Lima beans, a species as yet not seriously injurious but capable of considerable injury should conditions favor a further increase in its numbers. It was unknown to science at the time its study was begun. The same is true of a small Tingitid bug affecting beans in Alabama and the plant-louse previously mentioned, which has been seriously injurious to peas over a wide extent of the eastern United States, Nova Scotia, and Canada, and which has been considered in Bulletin No. 20, pp. 94–99, and elsewhere. These three species were described by Messrs. G. D. Hulst, Otto Heidemann, and W. G. Johnson, respectively, within a few weeks of the completion of the manuscript of this bulletin.

Among other bean- and pea-feeding insects which have come under observation are the smaller corn stalk-borer, which had not been known as troublesome since the first report of its injuries in 1881, and the Mexican bean weevil.

The pale-striped flea-beetle, a well known pest in the central portion of this country from New Jersey to Colorado and New Mexico, has been studied, and some new facts in its life history have been gained. This species is one that has not hitherto received special attention in previous publications of this Division, which is also true of several other insects mentioned in this bulletin.

Among cruciferous pests of the year the cabbage curculio and the imported cabbage webworm were conspicuous, and the former, though not so injurious as in certain previous years, occurred in numbers sufficient to afford a good opportunity for its study. Considerable has been added to our previous knowledge of the webworm, which has already caused serious injury in the Gulf region, and is evidently destined to become one of the most serious pests of the Southern States, and as troublesome in time to the truck grower as are the harlequin bug and cabbage worms at the present time.

Considerable attention has been given to the strawberry flea-beetle and the common rhubarb curculio, and rather full accounts of both species are furnished. Some new facts in the life history of the bean leaf-beetle and imbricated snout-beetle have been ascertained which add somewhat toward a complete knowledge of these insects.

Prominent among insect pests of the year 1899, and perhaps as

troublesome as any insect of the season, if we take the number of crops and the area of territory affected into consideration, was the fall army worm. Although properly a field crop insect, it does great damage in vegetable gardens in exceptional seasons like the past, and as at such times it affects a great number of garden crops, it may, for convenience, be appropriately considered, with regard to recent injury, in the present bulletin.

A departure has been made in presenting general accounts of a few species of insects which have not been under personal observation as regards their life history, habits and development. The principal of these are the strawberry crown moth and the black gooseberry borer, both pests of the Pacific States, and restricted to that region.

For bibliographical purposes it should be stated that, as in the writer's previous bulletins, Nos. 8 and 19, the comprehensive title used for the present publication is assumed as a matter of convenience, and that each article is in a manner complete of itself, having no especial bearing on either that which precedes or follows it, and hence each article should be properly indexed separately.

In conclusion the writer desires to thank those who have cooperated with him in completing the accounts here presented, and desires to acknowledge with gratitude the kindness of his official colleagues and correspondents of this Division for favors which will be duly mentioned in their appropriate places.

Of the illustrations here used 16 are original, and of these all except figure 8, which was drawn by Mr. Heidemann, were prepared from drawings made by Miss Sullivan from selected fresh material and under the writer's personal supervision.

F. H. C.

SOME INSECTS INJURIOUS TO GARDEN CROPS.

A NEW VINE-BORER OF LIMA BEANS.

(*Monoptilota nubilella* Hulst.)

BORERS IN THE STALK OF BEANS.

Until the appearance of a short note by Dr. A. D. Hopkins and Mr. W. E. Rumsey in Bulletin 44 of the West Virginia Agricultural Experiment Station, published in April, 1896 (p. 303), no boring insect, as far as the writer is aware, was known to infest the stalk or vines of the bean plant. The note in question mentions, under the heading "The bean-vine borer," that this was a new pest, and was observed in Wood County, W. Va., in July, 1893, where considerable damage was done, attention having been called to this form of injury by Mrs. Bradford Neal. The larva was described as a whitish worm, about an inch long and resembling very closely the well-known squash-vine borer (*Melittia satyriniformis*). The attack was upon pole Lima-bean vines, usually at a point two or three feet above ground. The moth was not reared, hence the species of insect was not identified.

In the fall of 1898 the writer noticed numerous large gall-like swellings upon Lima beans growing in Maryland near the District of Columbia line. The following season material was obtained for study and illustration, and the species was reared to the adult. During this same year Prof. F. S. Earle, of Auburn, Ala., sent specimens of the larvæ of borers in beans, one sending being made in June and another in August. From the first only a single male moth was obtained, and the second sending was an entirely different species of insect, the smaller corn stalk-borer (*Elasmopalpus lignosellus*). To the best of the writer's knowledge, neither of these two species of borer has been identified with injury to the bean plant until the present time.

Of the first sending received from Auburn, Ala., a larva issued *en route*, being near maturity at the date of its receipt, June 15. The moth developed July 7. Larvæ were not abundant at the time of writing.

A peculiarity in regard to the noticed appearance of this species in its more northern range is that it could not be found in any other locality visited, not even in gardens within from one to three miles of the place where attack was first noticed. In short, infestation

could be detected only in this one garden and only to pole Lima beans. Dwarf Limas, wax and navy beans in the immediate vicinity as elsewhere were not troubled.

NATURE OF ATTACK OBSERVED IN MARYLAND.

During November, 1898, vines of Lima beans growing in a garden in the vicinity of Cabin John Bridge, Maryland, were noticed with numerous large gall-like swellings upon them, the swellings being particularly evident where the vines were eroded and the injury accentuated by rubbing against a high lattice fence upon which they grew. Unfortunately it was too late that season to identify the insect which caused this damage, as all the plants were dead and dry and the insects had long since deserted their early homes. The injury bore some resemblance to that caused by the well-known stalk borer, *Gortyna nitela* Gn., which attacks a great variety of plants. The galls, as these swellings may be called, are quite large in some cases, and it was quite evident, as was subsequently verified, that when they occur in such numbers as in this instance they cause considerable drain upon the vitality of the plant which has a corresponding effect upon the production of seeds or beans.

A lookout was kept the following summer for an early attack of the same species, but unfortunately only a small planting of Lima beans was made in the infested garden, and no vines were planted along the fence. Judging by the number of galls seen in 1898, it seems probable that an immense number of the larvæ came to maturity that year, but there were comparatively few plants infested the following year.

Of the moths reared, the single male from Alabama and a female from Maryland were referred to Rev. George D. Hulst, of Brooklyn, N. Y., a specialist in the Phycitidæ, who determined them as of one species representing a new genus and a form as yet undescribed, to which he had given the manuscript name of *Monoptilota nubilella*. Owing to the unipectinate structure of the antennæ of the male (unique with the genus Ceara of Ragonot) the writer was at first in doubt as to the identity of the two sexes as one species, but this matter is now set at rest. As to the position of the genus, Dr. Hulst says that taking into account the most of its apparent affinities it may be placed after Phycitopsis and before Dioryctria, this position seeming to be indicated in some measure by Ragonot's Monograph.

The species may be known as the Lima-bean vine-borer.

THE SPECIES DESCRIBED.

The following description has been kindly furnished by Dr. Hulst, and although it has also appeared in the Canadian Entomologist of January, 1900 (Vol. XXXII, pp. 13, 14), it is deemed advisable to publish it entire here in connection with the illustrations. For the

benefit of those who have not given special study to the Microlepidoptera it should be said that of well-known moths this species bears a superficial resemblance to the genus Ephestia, which includes the Mediterranean flour moth and the still commoner though less troublesome dried-currant moth. It has, however, a more robust body; both pairs of wings are darker, the hinder ones more noticeably so and the pattern of the fore-wings is less distinct. The head is considerably larger and the male antennæ alone, as previously remarked, will serve to distinguish the genus from any other of the Phycitinæ. A female moth is shown twice natural size at *a*, the structure of the male antenna at *b*, fig. 1. The moth is subject to some variation as regards the markings on the wings, which are sometimes more suffused than in the specimen figured.

The wing expanse is about seven-eighths of an inch (21 mm. in the male; 23 mm. in the female).

TECHNICAL DIAGNOSIS OF THE GENUS MONOPTILOTA HULST.

Palpi ascending, second article heavy, third short; maxillary palpi small; front broad, flattened; ocelli not discernible in undenuded specimens; antennæ of ♂, first

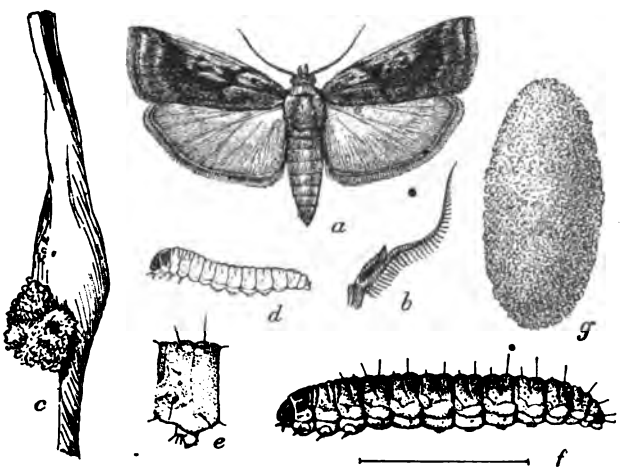


FIG. 1.—*Monoptilota nubilella:* *a*, female moth; *b*, antenna of male; *c*, gall of larva; *d*, young larva; *e*, first abdominal segment of same from side; *f*, mature larva; *g*, cocoon—all about twice natural size, except *b* and *e* which are much magnified (original).

segment much lengthened, swollen, followed by a decided, rather lengthened bend, hollowed on the inside into a deep furrow, or pocket, its entire length, the edges of the furrow scaled, becoming tufted on posterior edges outwardly; beyond sinus filiform; from beyond basal joint the antennæ are unipectinate, the pectinations one on each segment, filiform, being longest just beyond sinus and these five or six times the diameter of the stem, each armed with straight parallel hairs on each side; end segments ciliate. Antennæ of ♀ filiform, ciliate; thorax and abdomen rather stout, the genital armature of ♂ prominent. Fore wings rather elongate, subtriangular, 11 veins, 4 and 5 separate, 6 from cell near angle, 8 on 7, 9 and 10 from cell. Hind wings broad, 8 veins, 2 near angle, 3 from angle separate from 4, 4 and 5 stemmed half their length, 6 separate from 7; cell very short, not more than one-fourth wing length. Legs as usual in the group, rather heavy. (Hulst.)

TECHNICAL DESCRIPTION OF MONOPTILOTA NUBILELLA HULST.

Expands 21–23 mm. Palpi dark fuscous, lighter on inner side; front fuscous, much darker in front of eyes, and in one specimen purplish in middle; antennæ fuscous; thorax fuscous, with purple tint, more marked in front, and lightening into grayish behind; abdomen fuscous to light fuscous gray, somewhat purplish on anterior segments. All the segments darker lined; fore wings dark fuscous, broadly shaded with blackish longitudinally on veins, and lightened with white scales on anterior half and submarginally making these portions gray, with blackish dashes of ground color, the gray being most decided on subbasal and central anterior portion. Over the wings on the intervenular spaces is a purplish stain more evident posteriorly; cross lines faint, whitish, the inner shown mostly by the heavier dark angulate, somewhat diffuse blackish outer shading, the outer fine, rounded outwardly in middle with indistinct dentations; discal spots geminate, black; marginal line broken, black; fringe fuscous. Hind-wings dark, smooth fuscous, lighter basally and along inner margin, the lines darker; beneath even smooth fuscous, the fore wings the darker; marginal line blackish. (Hulst.)

DISTRIBUTION.

It seems probable, in spite of the few ascertained localities which we have concerning this insect, that its range extends well through the austral portions of Maryland, Virginia, and the District of Columbia, southward to Florida and Alabama, if not to a few neighboring Gulf States. It is obviously extremely local, and the abundance of individuals at Cabin John, Md., would appear to indicate that it perhaps extends some little distance farther north where the climate is suitable. At present it seems likely also that the species is a southern one and that it does not occur very far north in the Carolinian portion of the Upper Austral life area.

DESCRIPTIONS OF THE EARLIER STAGES.

The egg.—From a crippled female eggs were obtained August 16, but as they were not fertile and exceedingly variable in form a perfectly satisfactory detailed description was impossible. These were dull gray in color, irregularly oblong oval in form, and the surface was finely, distinctly, and rather regularly reticulated. The best formed specimens of egg obtained measured about 0.70 mm. in length by 0.40 mm. in diameter.

The young larva.—The youngest larvæ seen have polished, perfectly black head and thoracic shield; the body is dull light gray; the piliferous warts and a few dots showing distinctly on each segment, a little darker gray in color. The hairs naturally are longer in proportion and nearly white in color.

The larvæ between 10 and 12 mm. in length are darker, and those which have come under observation that are a little larger are dull green, darker above with dull carneous just beginning to show.

A young larva is shown in figure 1, at *d*, and an enlarged abdominal segment of the same in profile at *e*.

The full-grown larva.—The larva when mature is of striking appearance owing to the beautiful bluish-green color of the body. It is of robust cylindrical form, about five times as long as wide when extended, widest at the middle and tapering rather feebly till near the anal extremity. The general color of the body is glaucous or light sea-green (near verdigris green of Ridgway's nomenclature). The body is deepest in color, nearly blue on the ventral surface and in the thoracic region. The dorsal portion of the abdominal segments is darker and strongly marked as with an overlay, with dull carneous or pinkish. Segmentation is rather strong and the thoracic and abdominal folds are pronounced. The surface is rather sparsely clothed with rather long yellow hairs, short on the head and legs and longer elsewhere.

The head is a little less than half the greatest width, rather dark, nearly uniform moderately shining brown in color, becoming black near the trophi; inverted V-mark elongate, distinct. The first thoracic segment is a little narrower than the second and third; thoracic plate strongly transverse, moderately shining olive brown. Thoracic spiracle encircled with black; just anterior to this and a little below it is a small yellow chitinous patch of subtriangular shape, the apex directed obliquely slightly downward toward the head.

The first eight abdominal segments bear each a minute rounded piliferous wart on the side, smaller than, and located just above, the stigmata. Stigmata encircled with black. Last abdominal or anal segment strongly divided transversely, giving the impression of an extra segment. Anal shield weakly subtriangular, with the base rounded and the angles obtuse; color rather pale yellow, with margins marked with four fine black spots arranged like the corners of a rectangle. The three pairs of thoracic legs are well developed, as are also the four pairs of abdominal and the anal prolegs.

Length when full grown and extended, 21–22 mm.; width, 4.2 mm.

The mature larva is shown in profile in the accompanying figure 1 at *f*.

After the larva has spun its cocoon and is prepared for hibernation it undergoes a shrinkage, to about a third the size before its construction. Segmentation has become still stronger, and the body is now widest at the first and second thoracic segments. The colors have grown duller, the ground hue being green without the bluish tint.

The pupa.—The chrysalis or pupa is of robust proportions, and presents no characters worthy of special remarks. The color is rather dull olive brown, and the surface is moderately smooth and feebly shining in most portions except the wing-pads. These latter are nearly opaque, dull olive green, and reach in front to the bottom of the fifth

abdominal segment. The extreme tip is armed on each side with a minute spine, directed laterally and ventrally. Between these spines are four short, moderately coarse bristles. Length of specimen used in description, evidently male, 11 mm; width, 3.5 mm.

The cocoon.—Transformations take place in elliptical oval cocoons constructed of particles of earth or sand, joined rather firmly together by means of silk spun by the larva. One of these cocoons is shown at *g*, fig. 1. The average measurement is about 16 mm. long, and the diameter is about half that. These cocoons are usually formed in the immediate neighborhood of the infested plants, and such as have been observed were constructed close to the surface of the ground an inch or less below it.

The galls.—The galls at the time that the larva has reached full development measure about an inch to an inch and a quarter in length, that being the average length of the burrow of the larva within. In diameter they measure at this time about half an inch, but some have been seen later in the season that measured three-fourths of an inch.

The opening to a gall is usually made at one end, but occasionally near the middle, and of those seen a majority were placed at the lower end.

A gall with mass of exuding excrement is shown in figure 1 at *c*.

OCCURRENCE IN 1899.

Infestation was not noticed until July 8, but undoubtedly began earlier, when several vines were observed to be dying from within one to two feet of their tips, the leaves drooping over and slowly withering. Three or four holes were noticed on each of these vines, evidence that the parent insect had deposited three or four eggs upon each at rather regular intervals, and from these holes issued a small quantity of yellowish-white frass. The vines were in each case somewhat bent at the point of attack and some had already begun to assume gall-like proportions. Some of the vines were cut at this point and larvæ were found from a little less than a quarter to about half an inch in length. The largest burrows were at this time a little more than three-fourths of an inch long, one-eighth of an inch at the opening, and only about one-sixteenth in width, or just large enough for the easy passage of the larva up and down the vine.

The infested portions of vines collected July 8 were placed in a rearing jar and kept moist to prevent their drying. When examined July 17, one larva, about half grown, was noticed crawling about the jar. It was removed and placed in another jar with a fresh vine, and was found to have bored into this the following day. It is obvious, therefore, that the larvæ are capable of leaving an infested stem for another one as they crawl well and secrete a strong silk thread which readily supports the body, and thus they are able to let themselves

down without injury. Under ordinary circumstances, however, there is no necessity for a change of residence and there is no evidence that such change was voluntarily made during the season just passed.

July 25 and afterwards other visits were paid the infested bean patch, and by looking closely for fresh droppings upon the leaves, for gall-like swellings and dying and wilting leaves, a considerable number of the borers were secured that had escaped the first visit. When a well-formed gall results from borer attack it sometimes happens, particularly if the plant be well advanced in growth and the point of attack be low down upon the vine, that the plant does not appear to be in any great degree incommoded by the insect's presence, but it frequently happens on the other hand that the gall, if badly formed or made at a point where the plant is weak or weakly attached to the pole, becomes in time so broken open that the upper portion is killed. Several vines were thus found broken 4 and 5 feet from the ends. In one case a plant was observed that had lost three branching vines, all about 4 feet long and all bearing undeveloped pods.

From careful observations of all infested vines it was found that attack may take place at any point from the base of the vine on a level with the ground to within a few inches of the tip; that the result of attack varies greatly, a strong, well-grown plant being able to survive, while a weak one usually suffers in greater or less degree. As is so often the case with insect attacks, injury was much more noticeable at one end of the rows, the northern in this instance, than elsewhere, the southern end suffering somewhat less and the main portion of the planting still less. Attack had begun at the north end in the direction of the previous year's vines and ended at the southern or far extremity, since the larvæ matured much earlier in the vines at the former place than in the latter. One stunted plant attracted attention August 5. It was still green, but the leaves had all fallen away and there were no pods. It had been attacked two inches above the ground, and although the stem had not been severed, the plant had been practically a failure in consequence of the injury.

A few of the larvæ that were taken from the oldest parts of the largest vines were nearly full grown July 27, and by the beginning of the second week of August all but a few were mature, and some had escaped from the vines.

A mature larva was seen to leave its gall July 29, in the morning at about 11 o'clock. When the jar was next examined, at 2 o'clock the same afternoon, the larva had disappeared in the earth, and the following morning its cocoon was found attached to the stem in which it had lived, at the base, at the bottom of the jar.

Examination of the jar in which the other larvæ were confined showed that some had reached maturity and entered the earth a few days afterwards. One, however, was found August 1 which had just

molted, and was at this time only 3 mm. long. A majority of these larvæ would probably have left the vines before the middle of August.

From the observed fact that a bean vine if infested at all is usually attacked in two to half a dozen places, it is patent that a moth deposits several eggs on a vine before leaving it. In one instance two galls appeared about three inches apart.

As a rule only a single larva inhabits a gall, but one was found in which two were domiciled, one nearly grown, appearing to be the original habitant, and the other, less than half grown, an interloper.

THE SPECIES PARTIALLY DOUBLE-BROODED.

Two of the moths issued August 15 and these were all that were obtained that month from our rearing jars. One other moth issued September 7. Examination of the jars showed that they contained cocoons and when one of these was cut open, September 12, it was found to contain the larva.

The same day the writer visited the infested locality, finding that few larvæ still remained in their galls. It was also noted, as we had reason to expect, that a second generation had begun to attack the plants.

The second generation about the District of Columbia is a very small one, the majority of the first generation wintering over, probably as larvæ, as several species of insects are known to do here. In short, the species is only partially two-brooded, in this respect resembling the squash-vine borer and certain chrysomelid beetles, which are not fully double-brooded in this locality.

Farther north, if the species extends toward the Transition zone, which seems doubtful, there would be without doubt only a single generation, and southward in the Lower Austral we may be equally sure to have two well-defined generations each year.

A larva obtained in the field September 14, and undoubtedly of the second generation, required about a week longer to complete its growth and was found spun up September 26.

It is evident that the second generation is able to complete its development before the crop is made.

NATURAL ENEMIES.

The first generation of this insect appeared to be absolutely free from the attack of any natural enemies, either parasitic or predaceous, none of the galls harboring any other insect than its original occupant. In galls produced by the smaller generation a single parasitic pupa was found in September. This transformed to adult on the 4th of that month, and the specimen on being referred to Mr. Ashmead was identified as *Omphale livida* Ashm., originally described from Florida.

REMEDIAL MEASURES.

This insect could be kept in check by trimming and destroying the terminal vines when these are found to be infested, while the larvæ in the lower portions of the stem could be removed by cutting longitudinally without serious injury to the stem itself. This latter measure was employed by the writer to obtain specimens with comparatively little injury to the plant itself, and certainly with less than would have been accomplished by the larvæ had they been left until maturity in the stems. Such methods are, of course, irksome, but there is no other recourse, as insecticides can not be applied so as to reach the insect without an equal amount of labor. After the crop is gathered, harrowing the plats where the plants were growing in the fall would tend to expose the larvæ or pupæ to the elements, and then plowing deeply in the spring would have the effect of preventing the moths from issuing. This remedy has been tried against the squash-vine borer with success, and there can be scarcely any doubt that it would be productive of equally good results with the present species.

THE SMALLER CORN STALK-BORER.

(*Elasmopalpus lignosellus* Zell.)

Since the first recorded injurious occurrence of the so-called smaller corn stalk-borer in the Southern States in 1881, the species was not reported to be again troublesome, to the writer's knowledge, until the past year, 1899. Neither has it to our knowledge been previously observed to attack any other plant than corn, nor has it been recorded from Alabama, in which State attack came to notice during the year.

The notes which follow, concerning recent injury, show a much wider range of food plants than the species was formerly known to have, and imply some doubt as to whether corn or other Gramineæ are its original or preferred food plants.

REPORTS OF INJURY.

August 16, 1899, we received from Prof. F. S. Earle, Auburn, Ala., larvæ of this species in stems of young beans. The larvæ were in all cases found in that portion of the stalk below the surface of the earth, a hole showing near, apparently just at, the surface through which the larva had forced its excrement and in many cases made its escape before reaching us, as only a small proportion of the stalks sent contained larvæ. From this sending were obtained moths which began issuing during the last day of August and the first part of September. Concerning injury, Professor Earle wrote under date of August 29

that less than 10 per cent of the stand of beans from which the infested stalks were taken were left on the plat where infestation was noticed. No larvæ could be found at that time.

September 25, Mr. Thomas I. Todd, Athens, Ga., sent specimens of larvæ, with the report that they feed in growing peanuts and had destroyed in his vicinity a great many plants, sometimes as much as half a crop. The specimens when received were partly in the shells of the nearly mature nuts or tubers.

September 27, Mr. H. M. Simons, Charleston, S. C., sent larvæ, together with specimens of the stalks of snap beans showing injury done by them. The species was described as attacking beans at all stages of growth, from the time that the plant appears above ground until it comes in full bloom, and injury had been noticed even when the plants were fully mature and the beans nearly ripe.

October 2, Mr. Todd included a specimen of this larva in a sending of various species found eating the leaves of turnip. The larva was spun up at the side of the midrib of a leaf, being partially concealed in a web, and overnight ate a very considerable quantity of the leaf. Concerning its occurrence in peanuts, he wrote, in response to inquiry as to whether the proximity of corn did not have something to do with the attack, that the peanut patch where the larvæ were first observed was at least 200 yards from any corn, and that no corn had been planted nearer the previous year. Inquiry of his neighbors brought out the information that peanuts that were planted between each hill of corn were very little more subject to attack than where the peanuts grew distant from cornfields. Our correspondent also failed to find any corn that was infested. Larger borers, however, were found in the stalks, presumably either the corn ear-worm or the fall army worm.

DESCRIPTIVE.

The moth which produces this borer is a member of the family Phycitidæ, and until recently was known in most works as *Pempelia lignosella*, but is now referred to the genus Elasmopalpus of Blanchard. It is an exceedingly variable species, but typical specimens resemble rather closely the forms illustrated in figure 3. The moth measures about three-fourths of an inch in wing expanse, the females being usually larger. There is great difference in the two sexes, so great in fact that in ordinarily well-marked specimens the sexes look like distinct species. Besides the differences in antennal structure, which can at once be seen by comparison of the two figures (*a* representing the male and *b* and *bb* the female), the male palpi are longer and thicker. Pale yellow or ochreous is the prevailing color of the fore-wings of the males in well-marked individuals. This is bordered out-wardly, particularly at the ends, with dark purplish scales, forming a pattern

more or less like that represented in the figure of the male here presented, there being great variability as to the extent of the ground color and the border. In extremely dark individuals the ochreous is scarcely apparent save in a small portion of the middle of the wings.

In the females the wings are entirely reddish, purplish, or plumbeous, and in some cases nearly black. The head and thorax are usually light in the male and of the same color as the wings in the females. The abdomen in both sexes is gray. The hind-wings are transparent, light silvery fuscous, with a rather strong subbasal line on the inner margin of the cilia. The peculiar structure of the antennæ and mouth-parts of the male is mentioned somewhat in detail with enlarged figures in the report of the Commissioner of Agriculture for 1881. A portion of these have been adapted to figure 2, here reproduced. The variability of the species is shown by the different synonyms founded on colorational differences. Of these, *angustellus* Blanch. agrees with the type; *incautellus* Zell. differs in having the central portion of the fore-wings bright reddish; while *tartarellus* Zell. has the fore-wings plumbago or blackish.

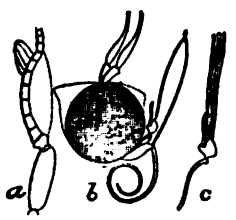


FIG. 2.—*Elasmopalpus lignosellus:* *a*, base of male antenna, dotted lines indicating outline of scales; *b*, head of male with mouth parts denuded; *c*, maxillary palpus of male—all greatly enlarged (after Riley, Rept. Dept. Agr. 1881).

DISTRIBUTION.

The original specimens of this species accompanying the first reported injury in the United States were received from Richmond County, Ga. The species was reported the same year at Atlanta, Ga., and Columbia, S. C., and as far north as Chapelhill, N. C. In the National Museum collection we have also specimens from Eufaula, Ala., Archer, Fla., Kansas, and Texas, the last State being represented by material from several sources, in all probability from as many localities.

Zeller recorded this species from Texas, and Dr. Hulst (Tr. Am. Ent. Soc., Vol. XVII, p. 159) added Florida, with the additional statement that it had been taken in the Bahamas, Venezuela, Buenos Ayres, Patagonia, and Chile. Zeller also records Colombia and Brazil.

It is evident from this that the species is of southern origin, obviously tropical, and perhaps introduced from the West Indies into subtropical North America. As no very extensive injury has been recorded since its original discovery of establishment as an enemy to agricultural interests, now nearly twenty years ago, it seems probable that there is very little immediate danger of serious injuries or of the insect's spreading much farther north than where it has been reported to occur in North Carolina; although this may be accomplished in time. The past year Mr. Aug. Busck obtained a perfect moth at Bladensburg, Md., in August, and Mr. F. M. Webster observed

this species several years ago at LaFayette, Ind. These captures, however, do not evidence the permanancy of the species in those localities.

THE EARLY STAGES OF THE INSECT.

The larva.—The larva is nearly cylindrical, upward of half an inch long when mature, and a beautiful object when viewed through a hand lens, pale green in color, marked above with nine reddish-brown longitudinal stripes arranged in transverse bands, forming on the different segments the patterns shown in figure 3 at *d*.

It is of elongate subcylindrical form, moderately depressed on the dorsum and a little more ventrally, and upward of eight times as long as wide. The general color above is in life pale bluish green, and the venter is paler green tinged more or less strongly with carneous. The blue and green colors fade in inflated specimens and in alcohol. The head is small, considerably narrower than the first thoracic segment,

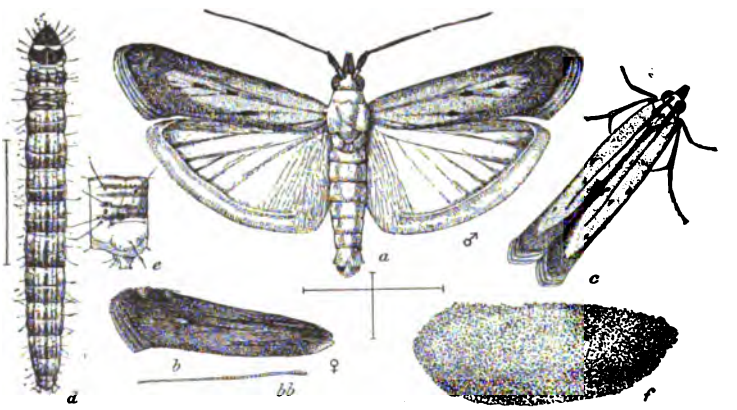


FIG. 3.—*Elasmopalpus lignosellus:* *a*, male moth; *b*, fore-wing of dark female; *bb*, antenna of female; *c*, male at rest; *d*, larva; *e*, ventral segment of larva from side, much enlarged; *f*, cocoon—all except *e* three times natural size (original).

and shining moderately dark brown in color. Prothoracic plate very dark brown, nearly black, polished, with the median line narrow but distinct. The thoracic segments are deeper bluish green than the abdominal, this color and the lighter abdominal ground color showing only near the sutures, where it forms in the anterior portion of each segment a transverse band, appearing at a little distance to be only about a fourth as wide as the remainder of each segment, but in reality (by closer inspection) fully a third of the whole segment. Segmentation is not pronounced, but the segmental folds, as seen from the side, are moderately prominent. Surface sparsely covered with moderately long hairs. Anal segment darker than the other abdominal segments, but scarcely with a pronounced shield as in many larvæ.

Length, 15 to 16 mm.; width, 1.8 to 2 mm.

Transformation to pupa takes place in a tolerably compact cocoon formed in the earth and covered with grains of sand or dirt. Such as have been seen were elongate, nearly reniform or bean-shaped, acutely prolonged at each end, and measured, when divested of such particles of sand or dirt as did not adhere closely, from 12 to 14 mm. in length and about 6 mm. in width. A cocoon is shown at *f* of figure 3.

LITERATURE.

During the year 1881 this species was the subject of some study on the part of Dr. Howard, as also of Dr. W. S. Barnard, at that time connected with this office. Among other things it was learned that it had never been noticed in this country prior to 1878 (Rept. Comm. Agr. for 1881, pp. 142–145). Brief mention of this stalk-borer as an enemy of corn has been given by Prof. L. Bruner in his report to the State Board of Agriculture of Nebraska for 1891 (p. 260), and this sums up all that the writer is able to find that bears in any way upon the biology of the insect. A rather full bibliography is given by Dr. Hulst (l. c.).

Figure 4 shows the nature of the work of this stalk-borer in corn.

FIG. 4.—Corn stalk showing work of maller corn stalk-borer—natural sizes (after Riley, Rept. Dept. Agr., 1881).

NATURAL ENEMIES.

Until the past year no natural enemies of this species had been observed, to our knowledge. From larvæ received from Mr. Todd, Athens, Ga., a hymenopterous parasitic larva issued October 15, and four days later was found to have transformed to a naked pupa, the adult issuing early in November. It has been identified by Mr. Ashmead as *Orgilus* (*Microgaster*) *mellipes* Say.

REMEDIES.

Previous observations have shown the practical impossibility of a perfect remedy for this insect, since it has been observed to hibernate in all three stages of larva, pupa, and adult.

Only two remedies suggest themselves: The plowing up and burning of the corn stubble or other infested material as early as possible after the crop is made, as already advised in the 1881 report, and rotation with some crop not affected by the species. It seems probable that this insect would not injure any of the smaller cereals, sweet potatoes, cotton, melons and other cucurbits, potato, tobacco, and

other solanaceous crops, asparagus and other vegetables, and this suggests the use of the small grains and the other field and garden plants as alternate crops. It is not likely that the insect could be reached with insecticides.

THE PALE-STRIPED FLEA-BEETLE.

(*Systena blanda* Mels.)

The frequency of the occurrence of the little flea-beetle, *Systena blanda* Mels., on cultivated crops in recent years, as shown by published record as well as by personal experience, has led the writer to look carefully through our literature and our divisional notebooks and to make such observations as have been possible toward a completion of our knowledge of the species. In the vicinity of Washington, D. C., the beetle has been noticed most often in connection with observations on the insect enemies of beans, but the larva has not been found on, and may not live at the expense of, this plant. The beetle is more often associated with corn than with any other crop plant, and the larva, although on one occasion found upon corn, without doubt feeds normally on certain common species of weeds, one of which was positively identified during the past season, while a second is more than probable. The still more common occurrence of the beetles on certain other forms of weeds indicates these as also larval food plants.

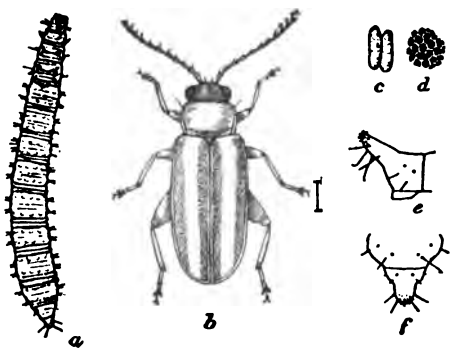


FIG. 5.—*Systena blanda*: *a*, larva; *b*, beetle; *c*, eggs; *d*, sculpture of egg; *e*, anal segment, from side; *f*, same from above—*a–d*, six times natural size; *e*, *f*, much enlarged (original).

DESCRIPTION OF THE ADULT.

The beetle known as *Systena blanda* measures about an eighth of an inch (3–3.5 mm.) in length and is about a third as wide as long. It is cream colored, with nearly black abdomen and eyes, and the elytra are ornamented with a broad sutural and two narrower marginal stripes of a dull, light-brown color.

Not infrequently the elytral stripes are obsolete. The head is reddish, the long, slender antennæ and the legs also marked with light brown, and the posterior femora are greatly enlarged like those of other flea-beetles. It resembles superficially the common cabbage flea-beetle (*Phyllotreta vittata*), but is much larger. The colors specified apply to the typical *blanda*, which is represented at figure 5, *b*.

Everything considered, this is perhaps the best-known species of its genus, from the frequency of its attacks on cultivated crops. The term species is used for convenience. Up to the year 1889 *Systena blanda* was considered to be a distinct species. In that year, however, Dr. Horn, in his Synopsis of the Halticini of Boreal America (Tr. Am. Ent. Soc., Vol. XVI, p. 273), relegated this form to varietal rank, placing it as a synonym of *S. tæniata* Say. It is not within the province of this note to discuss the validity of *blanda* as a species, nor dispute the opinion of our greatest authority on American Coleoptera. The question is largely one of opinion, and for present purposes at least *tæniata* and *blanda* may be considered distinct. A common form of *tæniata* is shown at figure 6. It is polished black with white stripes, having the same superficial appearance as *elongata* Fab., a common Eastern form. The references to published literature which will be cited pertain only to accounts in which *blanda* is either specifically mentioned or known to have been the species under consideration.

FIG. 6.—*Systena tæniata*, dark variety—about 6 times natural size (original).

DISTRIBUTION.

Systena blanda is a native American species, and was first described by the younger Melsheimer from Pennsylvania (Proc. Acad. Nat. Sci. Phila., Vol. III, p. 164) in 1847.

The distribution accorded by Horn includes "New England" and Pennsylvania to "Dakota," Kansas, Colorado, and New Mexico. It has been observed in the greatest abundance, according to available data, in New Jersey, eastern Pennsylvania, Maryland, Ohio, Indiana, Illinois, and Nebraska. Injuries have also been reported in Virginia, Georgia, Delaware, Michigan, and Arkansas.

The following list of localities is for the most part derived from material in the National Museum, and particularly from specimens in the Hubbard and Schwarz collection, and from the collections of the writer and Mr. Pratt, but includes also a number of recorded localities not represented by specimens:

"New York" (exact locality unknown); Cape May, Spring Lake, and Washington, N. J.; Allegheny, Chambersburg, and Kennett Square, Pa.; Newark, Del.; Marshall Hall, River View, Seat Pleasant, and Travilah, Md.; Colonial Beach, Woodstock, Rosslyn, Fortress Monroe, and Pennington Gap, Va.; Adrian and Monroe, Mich.; Champaign, Anna and northern Illinois; Chesterton, Columbia City, Paxtons, Sumner, and Tippecanoe County, Ind.; Lincoln, Nebr.; Harrison, Ark., and Jackson County, Ga. Specimens identified and labeled "blanda" are also present in the national collection from Winslow,

Tucson, and Yuma, Ariz.; Salt Lake City, Utah; La Veta, Colo., and California.[1]

Although the above localities show a wide distribution east and west and southward from Pennsylvania and New Jersey, the species is, on the whole, somewhat peculiarly Carolinian, at least as regards reported injuries. It has never been found, at least to the writer's knowledge, near New York City, and its occurrence in the Austral portion of New York State is doubtless rare. The exact locality in New England does not appear to be known, but it is not improbable that it is Connecticut, which includes a considerable strip of Carolinian territory. The species is evidently rare in the upper portion of the Carolinian region, and not common in the Austroriparian, if indeed it occurs there at all.

DESCRIPTIONS OF THE EARLIER STAGES.

The egg.—The egg is elliptical but somewhat inconstant in outline, about two and a half times as long as wide, and opaque, light buff yellow in color. The sculpture of the surface, as observed under a moderately high power of microscope, appears to be granulated, but under a higher lens it is seen to be divided into very minute and rather ill-defined shallow concave hexagonal areas arranged in sevens inclosed in hexagons. Length, 0.60 to 0.68 mm.; width, 0.25 to 0.27 mm.

The eggs are shown enlarged at *c*, fig. 5 and the sculpture at *d*.

Eggs were laid from June 10 to July 8, and all that were observed were deposited singly and in small masses of three or four, flat upon the leaves or attached to the sides of the tubes in which the beetles were confined.

The larva.—The larva is white and slender, resembling superficially Diabrotica and Epitrix, whose larvæ have been figured in previous bulletins of this series. The head is light brownish yellow and the legs are pale yellowish and faintly lined with dark brown at the articulations of the joints. The legs resemble those of Epitrix, ending in blunt padlike processes. The dorsal surface of the body is somewhat peculiar as regards the tubercles. These are so nearly obsolete as to render it difficult to locate them with certainty. Their arrangement is only approximately indicated in the illustration (fig. 5, *a*).

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[1] A very considerable proportion of these last-mentioned specimens have the sutural and lateral stripes black. Most of the individuals thus marked fall into varieties *mitis* and *ligata*, and may be considered *tæniata*. In other words, I have reserved the term *blanda* to apply more particularly to such forms of *tæniata* Say (Horn) as occur in the eastern portion of the United States (mostly in the Carolinian life area, although *blanda* appears to extend somewhat into the Upper Sonoran), while *tæniata* is reserved for those other very variable forms, such as *mitis* and *ligata*.

There is every probability that the form found in Colorado, Arizona, and New Mexico extends into Central America, as a species of Systena has been described by Clark under the name of *pectoralis*, which is, according to Jacoby, "perhaps identical with *blanda* Melsh." This latter form is generally distributed in Mexico and other States of Central America.

The most striking feature of the larva is, perhaps, the anal segment, which tapers to a conspicuous prolonged process, surmounted at the apex with a crown of short spines and four long stiff spinose hairs. This segment is shown enlarged, dorsal view, at *f*, while the lateral view (*e*) shows also the anal proleg. The surface of the body is moderately hairy, the hairs of varying length.

The length of the larva when full grown is about 3 mm., the width about one-eighth of that.

A somewhat more technical description of the larva is given by Mr. John Marten (Forbes's 18th Ills. Rept., 1894, p. 22).

The pupa.—The pupa also resembles those of Epitrix and Diabrotica, being of the same general appearance and having the anal segment ending in a pair of spines, described by Marten as brown, rather long, tapering, and very thick at the base. Length, 3.5 to 4 mm.

RECENT UNRECORDED OCCURRENCE OF THE SPECIES.

This flea-beetle was first observed on beans during the first two weeks of August, 1897, at Marshall Hall and Seat Pleasant, Md., eating the epidermis from the upper sides of the leaves, and was noticed in less numbers on bean leaves the following years. The first record of serious damage to beans which can be found is that of F. M. Webster (Insect Life, Vol. VI, p. 186), who states that it was very destructive to beans in Ohio in 1893, and that "large fields were seriously damaged."

In 1898 the species was quite abundant upon its wild food plants, and particularly noticeable by its occurrence on the pigweed, *Ambrosia artemisiæfolia*. That year at River View, Md., it occurred in such abundance as to outnumber any other species of beetle that could be obtained with a sweep net.

June 30 Mr. F. J. Dickinson, Chesterton, Ind., sent specimens, with the report that the species was causing much alarm through the neighboring country, and that the beetles appeared on a great variety of plants, but seemed to be doing the most damage to the potato.

July 5 the beetles were found at Colonial Beach, Va., in numbers on the cocklebur, *Xanthium canadense*, eating the leaves from the upper surface, and in this locality at least preferring this plant as food to the *Ambrosia artemisiæfolia*, which grew in the immediate neighborhood.

July 9 Mr. Dickinson wrote in response to inquiry that this species was injurious to melons and other cucurbits, turnips and other cruciferous plants, eggplant, beans, tomato, and potato, the last crop being the one that was most seriously damaged in that vicinity.

In 1899, Mr. Edwin C. Post, Monroe, Mich., under date of June 23, sent specimens, with the information that the species occurred in a sugar-beet field, presumably in that vicinity, which had been practically destroyed by them. They were described as quite active, jump-

ing about like fleas, and were found on only one other plant, specimens of which were inclosed and which proved to be *Ambrosia artemisiæfolia*.

The same year the species was to be found in its usual abundance upon the weed last mentioned, as also upon the black or garden nightshade (*Solanum nigrum*). July 1 it was observed on beans and upon Lima beans at Cabin John, Md.

July 11 and 12 Mr. Pratt, on the occasion of a visit at Travilah, Md., made a special search for the larva, with the result of finding a few individuals at the roots of lambsquarter, *Chenopodium album*, and Jamestown weed, *Datura stramonium*. The imagos reared issued July 22 and 23.

In a previous year the writer captured an adult near Washington, June 17, which had but just issued, being still immature at this time.

PUBLISHED ACCOUNTS OF FOOD HABITS AND INJURY.

What is evidently the first account of the habits of this species was published by Townend Glover in the Monthly Report of this Department for July, 1873 (republished in Ann. Rept. 1873, p. 152). In June of that year it was reported at Chambersburg, Pa., where it had "nearly devastated a field of corn, eating the leaves and leaving the bare stalks standing." In 1878 or 1879, according to Dr. Cyrus Thomas (*cf.* Webster), this insect "ravaged fields of growing corn in Illinois."

Other accounts containing information concerning the habits of this species may be briefly mentioned. In 1884 Dr. S. A. Forbes (13th Rept. Ins. Ill., 1883 [1884], p. 86) published a brief notice of its abundance on the leaves of strawberry and melon near Anna, in southern Illinois. In 1886 the same writer mentioned the rearing of its larva from kernels of sprouting corn in the earth (Can. Ent., Vol. XVIII, p. 177) and the feeding of the imago on the cocklebur, *Xanthium strumarium* (Ent. Amer., Vol. II, p. 174). In 1887, according to Mr. F. M. Webster, it occurred on potato vines in Tippecanoe County, Ind. (Indiana Farmer, July 30, 1887; Rept. U. S. Dept. Agr., 1887, p. 151). The same year Dr. J. A. Lintner recorded it on cotton in Jackson County, Ga. (Count. Gent., Vol. LII, 1887, p. 441; 4th N. Y. Rept., 1888, p. 155). In 1890 Mr. Webster again reported injuries at Lafayette, Ind., to beets (Tr. Ind. Hort. Soc. for 1890 [1891], p. 26.) The following year Mr. Lawrence Bruner included this species in a list of the insects observed in Nebraska attacking the sugar beet. White clover, purslane, and Amaranthus are also cited as food plants, and the opinion was expressed that this is liable to be one of the most destructive beet insects in the West (Bul. 23, Div. Ent., p. 15). He also treats of the species somewhat more at length (Bul. 16, Nebr. Agr. Expt. Sta., 1891, p. 60) in its relation to sugar beet, adding Chenopodium to the list of the food plants of the beetle, and remarking that it fed sparingly on the Cruciferæ.

The species mentioned by J. F. Wielandy in Insect Life (Vol. III, p. 122) as having been "very pestiferous" to various plants in 1890 at Santa Fé, N. Mex., and particularly to "Yosemite Mammoth bush beans (costing one-half a cent a bean)," is probably *blanda*, but the specimens received on that occasion are not, at the time of writing, available for identification.

In 1893 Dr. J. B. Smith reported it in great abundance in the southern and central counties of New Jersey. Near Bridgeton, June 26, "it had almost entirely destroyed every field of carrots," the injury being to young plants as soon as they appeared above the surface. The leaves of young beets were infested, "melons of all kinds were also attacked, and in one field of cantaloupes the injury done by these creatures exceeded the injury done by the striped beetles," *Diabrotica vittata*. Corn, purslane, and pigweed were also infested. In previous years the same writer had noted injury by this species to beans near Washington, N. J. (Rept. Ent. N. J. Agl. Coll. Expt. Sta. for 1893 [1894], pp. 478–480.)

In 1894 Dr. Forbes publishes the first account of the biology of this species, giving descriptions (by John Marten) of the larva and pupa and figuring the former.

Finally, in 1899, Prof. W. G. Johnson, of the Maryland Agricultural Experiment Station, reported this species to be injurious that year, the first report having reached him May 2, to Kieffer pear grafts. Damage was stated to be serious, and was accomplished by the beetle's eating out the terminals, thus stunting the growth of the trees. June 1, the same year, the species was reported to Professor Johnson as having destroyed 40 acres of tomatoes in Dorchester County, Md., injury being described as widespread, serious damage having been done in the Eastern Shore counties (Bul. 20, n. s., p. 63).

EARLY DIVISIONAL RECORDS.

Complaints of damage to the blades of corn have come to the Division from other sources than those published. Among these a few may be mentioned. Reports were received, with specimens, from John W. Spencer, Paxton, Sullivan County, Ind., dated June 22, 1885; from R. F. Smith, Columbia City, Ind., who stated that the species was "doing considerable damage to growing corn and oats," June 20, 1895; from B. F. Ferris, Sumner, Ind., reporting that this flea-beetle was "destroying the leaves of young corn as soon as they appear, thereby killing the plants."

The writer observed the beetles in some abundance the second week of June, 1891, at Kennett Square, Pa., eating the blades of corn and the leaves of *Ambrosia artemisiæfolia*, which grew between the rows of hills.

Of injury to other crops the following reported instances are worthy

of mention: July 23, 1886, Mr. E. W. Allis sent specimens of the beetle to this office, with the accompanying information that the species had been very destructive to early sugar beets that year at Adrian, Mich. A neighbor, Mr. H. C. Bradish, was also much annoyed with this beetle. Our correspondent noticed the abundance of the beetles on "hogweed," presumably *Ambrosia artemisiæfolia*. June 21, 1891, the species was received from Mr. M. H. Beckwith, Newark, Del., with the report that it was injuring the leaves of potato. May 25, 1893, Mr. J. G. Taylor, Harrison, Ark., sent beetles with the statement that they were injuring pear leaves, eating them partially, so that they colored and dried up. The damage was most apparent on young budded nursery stock of that spring's growth. The beetles were to a lesser extent injurious to foliage of young apple trees.

There are also specimens in the National collection labeled "on peas," and others "on peanuts," but without locality. There is also a note referring to the last specimens, stating that the beetles were destroying peanuts. The locality in the last case is probably St. Louis, Mo.; the date June, 1874.

PROBABILITY OF A SECOND GENERATION.

Adults have been taken by the writer in numbers as late as September 17 in past years in central New Jersey, and this late occurrence of the beetles, taken together with their observed issuance as early as the middle of June, has disposed the writer to the belief that there is probably a second generation of this species in a latitude like that of the District of Columbia, although an experiment that was made for the purpose of testing the matter met with negative results.

July 28, 1899, a considerable number of beetles were placed in a large rearing cage with a healthy potted plant of *Ambrosia artemisiæfolia*. It was examined about a month later and no trace of larvæ could be found, but the plant had begun to wither at this time. Although this is not conclusive evidence that there is not a later generation of *S. blanda*, it is significant as indicating the probability that the insects do not deposit eggs ordinarily after the end of July.

SUMMARY OF LIFE HISTORY.

From what has been recorded it is obvious that there is much to learn before we know even approximately the life history of this species, as, for example, when it makes its first appearance and begins egg laying, how and where the eggs are deposited, the period of ovulation, a full list of the larval food plants, and whether the species is single or double brooded.

At the present time we know that the species hibernates as a beetle, and appears above ground in this vicinity early in June; that egg

laying continues probably through that month and at least to the middle of July, if not two or three weeks later; that injury is due to the beetles upon their first appearance usually; and that almost any valuable crop may be injured, either in the absence or presence of the wild food plants; that the larvæ feed below ground, and probably have a wide range of host plants in addition to those which have been ascertained, which include at present only corn, lambsquarter, and probably Jamestown weed.

NATURAL ENEMIES.

Neither predaceous nor parasitic insect enemies have been observed of this species. The writer is under obligations to Dr. Sylvester D. Judd, of the Division of Biological Survey, for information concerning certain of its vertebrate enemies. During June and July, 1898, he observed two species of sparrows in wheat fields near Marshall Hall, Md., feeding upon the adult flea-beetles, which were at the time on *Ambrosia artemisiæfolia* growing between the rows of wheat. The chipping sparrow (*Spizella socialis*) was observed June 16 and 17, and specimens were shot and their stomachs examined. Eight of these contained individuals of the flea-beetle as follows: 8, 12, 5, 7, 8, 6, 12, and 14 specimens in each. The grasshopper sparrow or yellow-winged sparrow (*Ammodramus ravennarum passerinus*) was observed attacking this flea-beetle July 9.

REMEDIES.

Dr. Fletcher has reported finding that Paris green applied dry, mixed with twenty parts of flour and dusted on the infested plants, was thoroughly effective against this insect, and Professor Bruner obtained equally good success by the use of kerosene emulsion. The arsenites suggest themselves as the appropriate remedy, and, since Bordeaux mixture has been found to be particularly distasteful to flea-beetles, this substance, if mixed with Paris green and applied as a spray, should prove still more valuable than when used dry. Keeping down the weeds which are known to be, or which we have good reason to believe are, larval food plants, such as lambsquarter, cocklebur, pigweed, etc., should also be productive of good results. A good time for the destruction of these weeds would be about the middle of July, when most of the beetles have laid their eggs, and the larvæ have not yet attained full development. By pulling up and burning the weeds at this time the larvæ could be destroyed in great numbers.

Although the species is still periodical in its attacks, it is by no means certain that it will not prove injurious in some localities for two or more years in succession.

OBSERVATIONS ON THE BEAN LEAF-BEETLE.

(*Cerotoma trifurcata* Forst.)

Our knowledge of the life history of this species while not entirely complete, is so nearly so that no special effort has lately been made to learn more concerning it. Nevertheless a few facts have been observed and reported which are deserving of record. Among the cases of reported injury in 1899 that will be cited are some of unusual severity, a circumstance of some interest, since it bears out the prediction made by the writer two years ago (Bul. 9, n. s., p. 64) that the species was obviously increasing in abundance and injuriousness and liable to become a pest to the bean crop of the central Atlantic portion of the United States.

Injurious occurrence in Virginia and northward.—The species was as abundant in 1899 in the localities visited by the writer in and near the District of Columbia as in the two previous years.

May 30, 1899, specimens of the beetle were brought to this Division by Mr. George G. Hill, who stated that the insect was doing considerable damage to young beans at Falls Church, Va.

About the same time Dr. S. D. Judd reported the species in great abundance, and injurious to beans about a foot high, in the vicinity of Marshall Hall, Md.

June 5 we received word through Mr. E. B. Calvert, of this Department, that this species, a specimen of which was received, was doing much damage to string and Butler bean vines at Petersburg, Va.

June 6, Mr. E. M. Wright, Eureka, Ill., observed this species, which he identified from the description and illustration given in Bulletin No. 9, on wax beans in his vicinity.

Injurious occurrence in Alabama.—June 15 we received specimens of the larva from Mr. F. S. Earle, Auburn, Ala., together with affected bean stalks which were believed to be injured by it. The insect was described as an old offender. Writing under date of July 4, our correspondent stated that this species had been excessively abundant that year and had practically destroyed all the early plantings of beans; those planted after the middle of May, however, escaped injury. The beetles were described as being on hand, waiting for the plants to come up, and when the ground was cracked open by the seedlings the beetles went down and injured the minute plants badly before they could get above ground. In this respect injury resembles that so well known as being caused by the striped cucumber beetle, *Diabrotica vittata*, to cucumber and other cucurbits. The crop was sprayed three or four times with Paris green, but this did not save it.

Accompanying Mr. Earle's first letter were specimens of the roots and subterranean stems showing work both of the larva and of what

our correspondent described as four different kinds of serious fungus enemies, which considerably complicated matters. Early plantings of cowpea were said to have been injured almost as badly as beans. It was stated also, among other things, that farmers in north Alabama no longer attempted planting cowpeas before June on account of the injuries attributed to this insect. Velvet beans were growing side by side with beans in plots on the Experiment Station grounds at Auburn, Ala., and the former appeared to be entirely free from attack, while the latter were badly injured. Exemption from attack on garden pea had been noticed here as elsewhere.

Occurrence in other localities.—Among new localities where attack on bean was observed during the year were Alexandria, Va., Travilah, Md., and Louisiana, Mo. In the locality last mentioned, attack was reported by Mr. G. M. Dodge in a letter dated November 24.

At Bay Ridge, Md., the work of the beetle was evident on hog peanut, *Falcata comosa* (*Amphicarpæa monoica*), and although the larva was not found on this plant, the fact that no other known larval food plant or other plant, affected by the beetle grew in the vicinity is additional evidence that this is a true host plant of the larva. Beetles taken at this time on the vines deposited eggs July 25.

Early and late occurrences.—One observation on the occurrence of the bean leaf-beetle near Washington was the appearance of a newly transformed beetle June 30, which is nearly two weeks earlier than observed in 1897.

Beetles were taken as late as September 15, on which date considerable injury was noticed on the young terminal leaves of Lima bean at Cabin John, Md.

NOTES ON THE IMBRICATED SNOUT-BEETLE.

(*Epicærus imbricatus* Say.)

This species, which was treated somewhat fully by the writer in Bulletin 19, n. s. (pp. 62–67), has since come under observation on several occasions, having been studied in connection with insects affecting beans and peas.

Adults were observed July 8, 1899, feeding upon bush beans at Cabin John, Md., and two days later Mr. Pratt found the beetles at Travilah, Md., eating blossoms of Lima bean. All of the beetles seen at this date were badly rubbed and such as were kept died a week or two later, none remaining after the third week of July. July 29, 1899, a newly transformed beetle, as its bright color indicated, was taken on the foliage of tick trefoil (*Meibomia* sp.).

Although the life history of this species is incomplete, we have the principal data, with the exception of the most important—the larva and pupa and larval food plant. The above observations show that the

beetles of the new brood may appear within at least a week or two from the time of the demise of the hibernated parent beetles.

During the second week of August a fungus was noticed to be growing upon a specimen of this snout-beetle in our rearing jar, and was kept until it appeared to be fully developed, when a sketch which accompanies this note was made. The infected insect was referred to the Division of Vegetable Physiology and Pathology, and the fungus was identified by Prof. B. T. Galloway as a species of Sporotrichum, very close to, if not identical with, *S. globuliferum*. In the letter of transmittal the writer expressed the opinion that the death of the insect might be due to fungous attack, an opinion in which Professor Galloway concurs, since he writes that the fungus is an active parasite on many other insects, and there is therefore little doubt that it was the cause of the beetle's death. Attention is called to the bisymmetrical arrangement of the fungous growth upon the body of the insect in the accompanying figure.

FIG. 7.—*Epicærus imbricatus:* beetle attacked by fungus—three times natural size (original).

This species was rare the past season in the neighborhood of the District of Columbia as compared with previous years. Two complaints, however, reached this office from sources farther south. April 14, we received specimens of the beetles from Mr. David Hunter, San Antonio, Bexar County, Tex., with the information that the species was doing damage to peach, plum, and pear trees by feeding upon the buds and young foliage. The beetles had been troublesome the previous year and were jarred from the trees, but they again put in an appearance the following year in still greater numbers. May 15 Mr. T. G. Knoop, Glenwood, Okla., sent this species with others concerned in injury to apple trees.

A NEW TINGITID ON BEAN.

(*Gargaphia angulata* Heid.)

June 13, 1899, Prof. F. S. Earle, Auburn, Ala., sent specimens of this insect in different stages found on the leaves of bean at that place. Our correspondent had not noticed the insect before, but expressed the belief that it might be quite destructive.

The species was referred to Mr. Otto Heidemann of this division for identification, with the result that it was discovered to be a new species of Gargaphia, to which he has applied the name *angulata* from having found a specimen in the National Museum collection, labeled, in Pro-

fessor Uhler's handwriting, "*Tingis angulata* Uhler MS. on beans, Riley." The locality where Professor Riley made this observation is probably St. Louis, Mo., as most of the unlabeled material from the Riley collection was obtained in the early seventies in the vicinity of that city. As the facts concerning this species are meager, it was thought best to describe the species in a periodical publication rather than in our general series; hence Mr. Heidemann's description was sent to the Canadian Entomologist, and appeared in the issue of October, 1899 (Vol. XXXI, p. 301). The species may readily be determined by this description and by comparison with the illustration which is presented herewith.

FIG. 8.—*Gargaphia angulata*, much enlarged (original).

It is, as stated by Mr. Heidemann, closely allied to *G. viridescens* Champ., from Mexico and Texas, but differs by the angulated sides of the pronotum, by the larger number of areoles at the costal area, and the longer hairs at the edge of the pronotal margins and of the hood. It is also allied to *G. nigrinervis* Stal., from Colombia and Mexico, but does not have the discoidal area of the hemelytra abruptly closed behind by a transverse, oblique raised nervure.

THE DESTRUCTIVE GREEN PEA LOUSE.

(*Nectarophora destructor* Johns.)

Most remarkable of all the injurious occurrences of insects on edible leguminous crops during the year 1899 was that of the green pea louse, *Nectarophora destructor* Johns., which has overrun and laid waste fields of peas from Nova Scotia and Canada to Virginia and Maryland. It was first reported simultaneously from Virginia and Maryland, and has already been the subject of communications by Professor Johnson, published in Bulletin No. 20 of this Division (new series, pp. 94–99) and elsewhere. The notes which follow may be considered as supplementary to Professor Johnson's articles; the object of the present paper being to record the facts concerning injuries observed and reported to this Division.

INJURIOUS OCCURRENCES OF THE YEAR 1899.

Injury was first reported to this office May 17, when we received from Mr. Thomas Bridges, Bridges, Gloucester County, Va., specimens of the insect, with the report that it was destroying the pea crop in that county. About 1,000 acres of peas were stated to be planted there, and many farmers had already begun to plow them under. The same day Mr. John T. Griffin, Portsmouth, Va., wrote us concerning

the same species, with the report that it was very destructive to the pea crop in that section. May 23 we again received specimens from Mr. Bridges, with the accompanying statement that the species had destroyed the pea crop of that vicinity for shipping purposes, and was then destroying the Canada field peas sowed for hay. The same day a communication was received from Professor Johnson in regard to this insect, which, as this has already been treated in detail in Bulletin No. 20, need not be repeated here. A few days later, Mr. E. D. Sanderson called the writer's attention to this plant-louse and its injuries at College Park, Md., when upon examination of our experimental plats of peas growing on the Department grounds the writer found the same species at work there.

June 2, Prof. G. Harold Powell, Newark, Del., sent specimens, with report that this plant-louse was very abundant on the pea crop throughout the State.

July 3 we received specimens from Mr. D. W. Watrous, East Hampton, Conn., with the statement that "Champion of England" peas were being injured by this insect, the plants being covered with their numbers.

July 7 we received, through Dr. E. P. Felt, Albany, N. Y., specimens from C. J. Allen, Floral Park, Long Island, with the report that one farmer in that vicinity had lost 14 acres and another 20 acres of peas through the ravages of this pest.

July 28, the late Prof. F. L. Harvey, Orono, Me., transmitted specimens, with the accompanying information that this pea louse had been doing a great deal of damage to peas in Maine, several complaints having reached the experiment station. The insect was also abundant in gardens about Orono.

August 9, Dr. James Fletcher, Ottawa, Canada, sent specimens received from New Minas, Nappan, and Truro, Nova Scotia, and from Freeman, Ontario. Dr. Fletcher's correspondent from the last locality wrote, "this is only a fair sample from a 14-acre field; it looks as though the whole crop would be lost." August 22, Dr. Fletcher wrote that this plant-louse attacked not only field peas but tares, and that on the experimental farm at Ottawa it had ruined two long hedges of sweet peas.

August 12 we received specimens from Mr. A. Brakeley, Bordentown, N. J., with the report that his first crop of peas had suffered considerable injury, perhaps one-third being lost; the second crop about two-thirds, while the third crop of 34 acres yielded only a few hundred cans.

From October 30 to November 4 we received specimens in different lots from Mr. Samuel R. Haynes, Portsmouth, Va., from which locality we have previously reported it as very destructive.

Writing December 20, 1899, Mr. C. H. Pearson, of Baltimore, pro-

prietor of the Susquehanna farm in St. Marys County, Md., stated that during that year he had 600 acres of peas and the crop was badly infested by this pea louse, which destroyed 80 per cent of his crop. This loss was a very serious matter, as our correspondent raised no other crops except peaches.

A large proportion of the identifications of the material received were made by Mr. Theodore Pergande, who has also kindly criticised the accompanying illustration of this plant-louse.

THE SPECIES DESCRIBED.

The species was described by Professor Johnson in the February number of the Canadian Entomologist of the current year (Vol. XXXII, pp. 56–60) under the name *Nectarophora destructor*. Attention is called in that article to the preoccupation of the genus Siphonophora both in the Myriapoda and Hydrozoa, for which reason Nectarophora of Oestlund is substituted.

This plant-louse is one of unusual size among those found infesting garden plants, the average length of the body being about 4.5 mm., and the total wing expanse about 11 mm. The general color of both the winged and apterous forms is uniform pea-green, the same color as the insect's favorite food plant. The eyes are prominent and reddish brown in color. The antennæ are lighter than the body and tubercles prominent; joints darker than rest of segments; seventh joint quite filiform and fuscous. The legs are long and conspicuous; tarsi, distal ends of tibiæ, and femora fuscous. The nectaries are fuscous at the apices, otherwise concolorous with the body.

A typical winged female of this insect is shown in figure 9 with wings expanded, showing venation at *a*, and a lateral view of the same with wings folded in their natural position when the insect is at rest or feeding is presented at *b*. At *c* an apterous or winged insect is shown, and *d* shows the nymph in its last stage. The structure of the third antennal joint of the winged form may be seen at *e*, highly magnified.

THE QUESTION OF ALTERNATE FOOD PLANTS.

An effort was made by Mr. Pergande to ascertain if any common species of weeds that were found growing late in October and early in November could be alternate food plants of this insect, but with negative results. The plants upon which the insects were placed, but which they deserted, were *Sonchus asper*, dandelion, shepherd's purse, *Sisymbrium officinale*, and dock.

Throughout the months of November and December, 1899, this or a related plant-louse was observed and is still to be seen on the Department of Agriculture grounds, feeding upon different species of vetches (*Vicia villosa, gigantea, ludoviciana, et al.*) on the experimental plats of

the Division of Agrostology. Large colonies were at work on pleasant sunny days in January, 1900. Many winged individuals occurred at this time and living specimens were in fact to be found all winter, having been last seen March 24 or up to the time of going to press. Unfortunately, winged individuals were not preserved, and a specific determination can not at present be made.

NATURAL ENEMIES.

In spite of the numbers of insects of parasitic and predaceous habits observed by Mr. Johnson and noticed in his article, it was patent to all

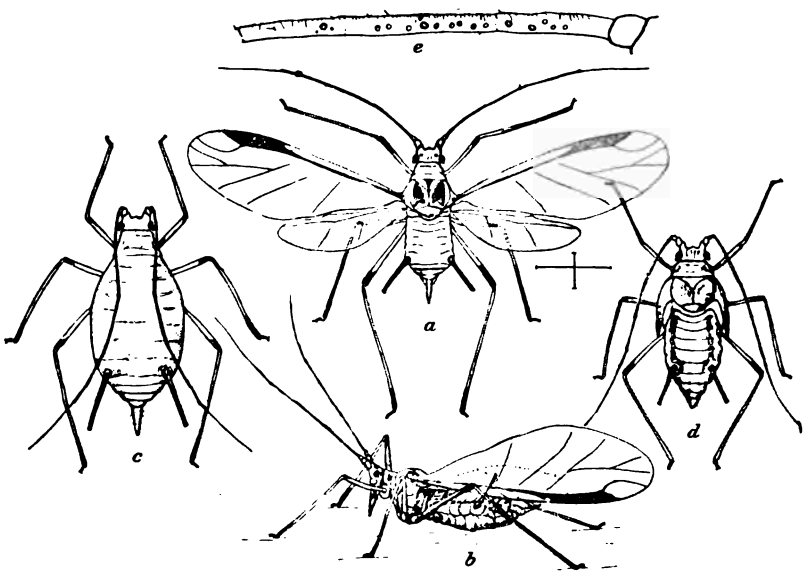

FIG. 9.—*Nectarophora destructor: a*, winged female; *b*, same from side with wings folded in natural position when feeding; *c*, apterous female; *d*, nymph in last stage; *e*, third joint of antenna of winged form—*a-d*, much enlarged, *e*, more highly magnified (original).

who had the species under observation that few of these had any very perceptible effect upon lessening the immense numbers of their host last year.

From Dr. Fletcher we received October 17 some parasites of this species which were identified by Mr. Ashmead as *Praon cerasaphis* Fitch, *Aphidius fletcheri* Ashm. MS., and *Isocratus vulgaris* Walk.

A list of Syrphus fly, ladybird beetle, and other natural enemies of this species has already been furnished by Professor Johnson in his article previously referred to and need not receive further attention here. From the abundance of some of these natural enemies Professor Johnson has expressed the opinion that the insect will not again be so injurious in many years as was the case the past season. In the vicinity of the District of Columbia none of the natural enemies were at all

active during the crop growing season, and there is nothing to indicate that we will not again be visited by this plant-louse here, especially since this or an allied species of plant-louse, as previously observed, was active in the field during the winter months.

It is worthy of remark that Professor Johnson kept the insect feeding upon clover. Though we have been unable to find specimens on clover in this vicinity, only one variety of common white clover growing in the garden patch where the insect was noticed, possibly they may show greater preference for another variety of clover or other perennial plant. Should no such plant be available in other districts, it might be the cause of the insect's dying out to a very considerable extent.

REMEDIES.

Nothing new in the line of remedies has developed during the season. Our correspondents have been advised to use kerosene emulsion, the standard remedy for plant-lice, and it has been suggested that some benefit might follow the rotation of crops. It is a matter of considerable importance that the preferred alternative host plant or plants, if such exist, be discovered, so that the insect may also be killed upon them after their departure from the old pea vines, and that their cultivation may be avoided in the vicinity of peas and other crop plants subject to injury by this insect.

A NOTE ON THE MEXICAN BEAN WEEVIL.

(*Spermophagus pectoralis* Sharp.)

November 15, 1899, we received from Mr. Jared G. Smith, of the Division of Botany of this Department, specimens of a large bean, evidently native to the place from which it was received—Lima, Peru—and infested by the exotic Bruchid, to which the writer has applied the name of Mexican bean weevil, and which has previously received mention in recent publications of this Division as *Spermophagus pectoralis* Shp.

This adds a new locality to the list given by the writer in volume VII of Insect Life (p. 328).

Careful comparison of the large series of this species now in the National Museum collection with the description furnished by Schoenherr of *Spermophagus semifasciatus* points strongly to their identity.

In the year 1858 M. H. Lucas presented before the Entomological Society of France a few remarks on the habits of *S. semifasciatus*, describing the male, which was not noticed by Schoenherr, and evidently also not known to Sharp in his treatment of *pectoralis*. As this communication is brief and of considerable interest, a translation is given herewith:

I will communicate to the society several individuals of both sexes of a Curculionid belonging to the genus Spermophagus which destroys haricots, coming from La Plata, and which I owe to the extreme kindness of our colleague, M. Allard. On studying the legumes attacked by these insects it is remarked that a single haricot often nourishes seven and even eight individuals of the Spermophagus. The larva feeds on the germinative part of the bean, makes in it larger and smaller galleries, and transforms finally into nymph. When the haricots containing these Spermophagus are examined nothing on the exterior reveals the presence of the Curculionids; the nymph changes into the perfect insect, and the latter, in order to issue from the cell in which it has undergone its various transformations, cuts the pericarp of the bean, making with its mandibles a piece more or less circular, which falls, and the perfect insect issues very actively from its cell to go in search of the female. It is to be remarked that often the same bean serves as the cradle of several individuals of both sexes. The learned Schoenherr is the first who has made known this species, to which he has given the name *Spermophagus semifasciatus*, Genera et Spec. Curcul. tom. I, partie I^{er}, p. iii, No. 12; but he knew only the female and did not add to his careful description the life habits of this pretty little species.

The male is smaller than the female, for it is only about 1.75 to 2 mm. in length. It is entirely gray, more or less variable ("chatoyant"), tending a little to reddish, and the elytra are traversed by striæ, showing a punctuation fine and not very close; the legs and all the body beneath are of a clear ashy gray. The antennæ are gray with their first joints reddish. (Annales de la Soc. Entom. de France, 1858, bul., p. xxviii.)

When it is added that this bean weevil evidently lives for successive generations on stored beans and cowpeas in the same manner as *Bruchus obtectus*, the common bean weevil, and that it is known to inhabit Guatemala, Nicaragua, and Panama, besides Mexico, Peru, and Brazil, we sum up about all that is known concerning it.

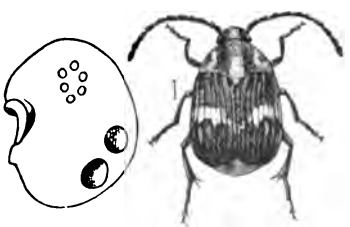

FIG. 10.—*Spermophagus pectoralis:* weevil at right, much enlarged; Mexican bean at left, showing: below, holes made by beetle in egress, above, a group of eggs on surface, three times natural size (author's illustration).

For the further identification of the species, the illustration of the female and of an infested seed, with eggs and exit holes, is reproduced:

The eggs are deposited in great numbers on the beans recently received, from 50 to 100 on each. The eggs, when dry, are light gray in color, nearly circular in outline, about half a millimeter in diameter, and less than half that in depth.

It seems quite likely that this insect has already obtained a foothold in our new possessions, where it will in time become quite as destructive as in the other countries where known to be established, and it is almost equally probable that it will spread, with the increase of our commerce with those countries, to the Southern States.

It has confidently been hoped that an opportunity would offer for the further study of the Mexican bean weevil, but since the taking by the writer of living material at Chicago, during the Exposition held there in 1893, no live individuals have been obtained.

THE CABBAGE CURCULIO.

(*Ceutorhynchus rapæ* Gyll.)

RECENT OCCURRENCE AND INJURY.

During June of 1897 Mr. B. R. Bones wrote to this Department concerning damage to cabbage in the vicinity of Racine, Wis., and later, June 20, sent specimens of the larvæ of the insect concerned in the injury, which proved to be of a species of Ceutorhynchus and the one that has been known in American entomological literature until very recently as *C. rapæ* Gyll.

Incidentally it might be remarked that our correspondent wrote that the loss in his neighborhood during the fall of that year was over 2,000 tons of cabbage rotted in the field and in storehouses, this loss being due probably to cabbage rot, which he believes is disseminated by this insect.

August, 9, 1898, Mr. Henry J. Gerling, St. Charles, Mo., wrote of injury to the stems of kale, which is with little doubt due to this same species. He was, however, unable to find specimens. The plant begins to rot just below the leaves, and this follows the stem down to the ground. There appears a small opening in the top part of the stem, which grows from 2 to 8 feet high, and it is hollowed out sometimes far into the ground.

During the first week of May, 1899, the beetles of this species were observed in considerable numbers on the hedge mustard, *Sisymbrium officinale*, an introduced European weed that grows almost everywhere in meadows and in waste places in this country, and which is particularly abundant in the vicinity of the Department of Agriculture. The beetles were all observed singly at this time, preferably on plants of advanced age that were already in flower, and were usually hiding beneath or near the buds and flowers. Later the species was observed on turnip and horse-radish at Tennallytown, D. C., as will be related in detail in the account of the life history and habits of the species.

June 26, 1899, Mr. Bones sent, by request, another lot of young cabbage plants showing injury by what is now proved beyond doubt to be this species, by finding the larvæ in some of the affected stalks. The plants were between 3 and 4 inches in height, and in many cases the larger leaves were wilted. The stalks showed the punctures made by the female in the deposition of her eggs, and in some cases a hole had appeared just below the base of the leafstalk, through which the larva, which was found within, was forcing its soft, brown castings. Larvæ were nearly mature at this time, and some few had evidently already left the plants. The burrows are quite short where only a single larva is present in the stalk, measuring only about 7 or 8 mm.

in length. In figure 11, *a*, a stalk is opened, showing a larval burrow. At the point where the castings are forced out, which may be the same place where the egg was first deposited, the plant fibers become so stretched that the scar gives to the plant the appearance of being partially split open at this point. Such a stalk is shown in the figure at *b*. Our correspondent writes that the work of the curculio was more apparent in early seed beds. In 1898 the insects were very scarce, and he stated that his plants did not suffer from the rot. He con-

FIG. 11.—Work of *Ceutorhynchus rapæ* in young cabbage: *a*, stalk opened to show larval burrow; *b*, scar left after escape of larva from stalk—natural size (original).

siders this curculio to be the main source of inoculation of the cabbage rot, the beetles going from sick to well plants in the seed beds.

EARLY OBSERVATIONS; REMARKS.

In the collection of the National Museum are series of specimens labeled: "From Allis, Adrian, Mich., seed cabbage, April;" "St. Louis, Mo., horseradish, April 20" (identified by LeConte as *C. rapæ*, January, 1876); "From A. J. Cook, Lansing, Mich., on cabbage."

This curculio is well known as an injurious enemy to cabbage and other cruciferous crops and has received mention as such in the Annual Report of this Department for 1889 by Miss M. E. Murtfeldt (pp. 136, 137), as well as elsewhere, but has not hitherto been figured in Departmental publications, and considerable has been learned by the writer that has not previously been recorded.

The prediction made by Miss Murtfeldt, who stated ten years ago that this insect gave promise of becoming a general and very considerable pest to our market gardeners, has hardly been realized to date, notwithstanding its present very general establishment throughout the Upper Austral area, as well as adjacent regions in the United States and Canada, and in spite of evidence that the species has been established in this country at least since 1873, as will presently be shown.

THE SPECIES IDENTIFIED.

Attention must be called to the unfortunate determination of the species in different publications, and an endeavor will be made to straighten out this difficulty.

According to Dr. William G. Dietz, the cabbage curculio of this country is not the true *rapæ* of Gyllenhal, but a native American species and undescribed until 1896, when he gave it the name of *C. affluentus* in his revision of the Ceutorhynchini inhabiting North America (Trans. Amer. Entom. Soc., Vol. XXIII, p. 421). He says: "This species, erroneously known in our lists and collections as *rapæ* Gyll., bears only a superficial resemblance to its European congener while differing in most important structural characters." He then specifies the points of difference, emphasizing more especially the unarmed femora and claws of *C. rapæ*. In the course of the arrangement of the Ceutorhynchini of the national collection, Mr. Schwarz gave this matter some study and has satified himself, as has also the writer, that Dr. Dietz's conclusions were erroneous. In Gyllenhal's original description of *C. rapæ*, published in 1837 (Schoenherr's Gen. et Spec. Curculionidum, Vol. IV, p. 547), there occurs the following: "*femoribus parum crassis, subtus dente mediocri armatis*," and in Thomson's description of the same species, published in 1865 (Skandinaviens Coleoptera, Vol. VII, p. 271), that writer says "*Femora denticulo armata. Unguiculi tarsorum bifidi.*" In Bedel's synopsis of species of Ceutorhynchus (Faune des Coléoptères du bassin de la Seine, 1885, Vol. VI, pp. 163–171) the toothed nature of the femora and the claws of *C. rapæ* are also referred to.

Among the European material which we have had for the study of the genus Ceutorhynchus is a specimen identified by a European authority as *rapæ*, which is manifestly an incorrect determination, since the femora are mutic and the claws simple. It is possible that

Dr. Dietz obtained his specimens of the alleged "*rapæ*" from the same source, and hence the unfortunate error.

For this reason it seems to be advisable to consider our cabbage curculio as being identical with the European *C. rapæ* as long as the contrary is not proven by comparison with correctly determined specimens.

It should be added that *C. napi* Gyll. is entirely distinct and scarcely to be confused with *rapæ*, except by the most superficial study. The habits of both species of feeding upon Cruciferæ were known to their describers, as evidenced by their specific names.

European systematists have lately adopted as the spelling of this genus, Ceuthorrhynchus; but as the original characterization by Germar gives Ceutorhynchus (Insectorum Species, Vol. I, p. 217), and no valid reason is known to the writer for the change, the latter spelling is retained.

INTRODUCTION IN AMERICA.

It appears probable that the cabbage curculio was introduced into this country and had established itself at a comparatively early period, and that the point of its original introduction was in New England and not far from the coast line. As early as the winter of 1873–74 Messrs. Hubbard and Schwarz obtained specimens at Lynn, Mass., and at that time, Mr. Schwarz assures me, he saw specimens in the collection of Mr. E. P. Austin, which had been collected in the same district and prior to that date. No record appears to have been made of the dates of earliest capture. Possibly, however, the species referred to by Dr. A. S. Packard in an account which he gave many years ago of what he called the "radish-seed weevil," and which was identified as *Ceutorhynchus assimilis* Payk., in his second report of the insects of Massachusetts (Rept. Mass. Board Agr. for 1871 [1872], pp. 341, 342; 9th Rept. U. S. Geol. and Geogr. Surv. for 1875, pp. 763, 764), may have been this insect. This is the more probable, as one of the illustrations (made from an American specimen) fits *rapæ*, as does also the description. The singular identification of this insect, whatever it may have been, was obviously made by comparison of specimens, with the description and illustrations furnished by Curtis in his "Farm Insects" (pp. 104–106). The insect was stated to have been found in Maine in 1857 upon radish leaves, and it would seem unnecessary to state that the identification was incorrect, since the true *C. assimilis* is European and not as yet known to occur in America.

DESCRIPTION OF THE SPECIES.

The mature weevil measures about an eighth of an inch and is of broadly oval form, being about three-fourths as wide as long.

The body is somewhat depressed above, the thorax is prominently longitudinally sulcate or channeled at the middle, and is gradually narrowed toward the head, near which it is constricted. The head terminates in a rostrum or snout, which is longer than the thorax. Near the middle of the rostrum are inserted the elbowed and clubbed seven-jointed antennæ. The femora or thighs bear each a tooth on the ventral surface, and the claws are armed with a long, nearly bifid tooth.

The entire body of hibernated specimens is uniformly clothed with a light-gray vestiture consisting of piliform scales, while newly bred individuals, as was learned by the investigations of the season, are coated with ochreous scales. The real color below the scaly covering is black, and the older individuals appear leaden-gray in color and the fresher ones fulvous. Such a difference in coloration imparts to the insect quite a distinct appearance, so obvious that Dr. Dietz has separated the fulvous form as a variety. The elytra are longitudinally striate, as shown in the illustration (fig. 12, *a*). A side view of the insect, showing rostrum and antennæ, is furnished at *b*.

Full measurements give the length, exclusive of rostrum, at 2.7 to 3.25 mm.; width, 1.6 to 2 mm.

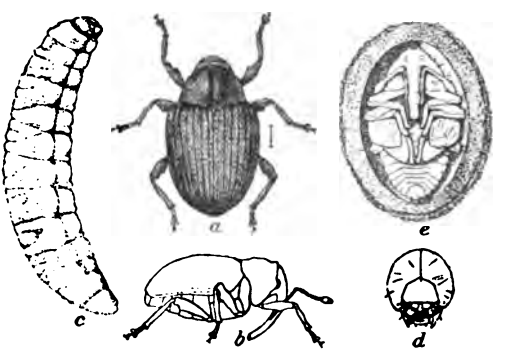

FIG. 12.—*Orutorhynchus rapæ*: *a*, beetle; *b*, same in profile; *c*, larva; *d*, head of same; *e*, pupa in cocoon; *a*, *b*, *c*, *e*, eight times natural size; *d*, more enlarged (original).

DISTRIBUTION.

The cabbage curculio is evidently abundant in its native home, its range extending through northern and middle Europe.

The habitat accorded by LeConte and Horn is: "Canada, Eastern and Western States." The exact localities from which specimens have been taken, as exemplified in local collections and as shown by available records, include: Lynn, Mass.; Ithaca (July 5–24) and New York, N. Y.; West Hoboken, N. J. (Juelich); southwestern Pennsylvania (Hamilton); Marshall Hall, Md.; Washington, Tenallytown, D. C.; Rosslyn, Va. (May 5–June 14); Dayton, Port Clinton, Xenia, Waterville, and Wooster, Ohio; Glasgow, St. Charles, and St. Louis, Mo.; Illinois (Hamilton), southern Illinois; Adrian and Lansing, Mich.; Racine, Wis.; Kansas (Snow); Coolidge, N. Mex. (Wickham); Canyon City, Colo.; Argus Mountains (April) and Los Angeles, Cal. The following States are also represented without definite localities: Maryland, Iowa, Kansas, and Nebraska.

The species is evidently most common in the Upper Austral life zone, although it extends into what is considered Transition. The fact that it ranges throughout the Upper Austral zone from ocean to ocean is another link in the chain of evidence of its being an introduced species.

DESCRIPTIONS OF THE EARLIER STAGES.

The egg.—The egg is of rather large size as compared to the beetle, and extremely irregular in outline. Of ten eggs examined, two were broadly oval and two were subpyriform, the remainder being elliptical oval. The color is clear, nearly transparent gray, and there is no visible sculpture, the surface being highly polished. The consistency is fairly firm. The length varies from 0.65 to 0.85 mm. and the width from 0.35 to 0.45 mm.

The larva.—The larva is elongate cylindrical, when full grown measuring about four times its greatest diameter. In color it is milk white, with pale brown head. Its body is much less curved than is usual in the Rhynchophora, the curvature when in natural resting position being about as shown in the illustration (fig. 12, *c*). It tapers abruptly and about equally at each end, the small head being of about the same width as the anal segment. Segmentation is quite pronounced at the sides as viewed from above, moderately on the venter as viewed from the side and feebly on the dorsum. The surface is feebly wrinkled as compared with many rhynchophorous larvæ. The transverse lines and ridges of the dorsal and lateral surfaces are fine and straight. Alternating with these there are transverse rows of minute rounded tubercles, some of them piliferous, the hairs arising from them being extremely fine and short, so fine, indeed, as not to be visible under an ordinary hand lens. The head (*d*) is nearly circular in outline, pale yellow in color, with brown mandibles. The V-space and temporal suture are rather faintly defined. The mandibles are bidentate and the surface carries a few fine short hairs like those on the body. This larva has no appearance of leg pads as are to be found in many Rhynchophora.

The length, curved as in the illustration, is about 5 mm.; and when extended 6 mm., the width being about 1.3 to 1.4 mm.

The pupa.—The pupa with its snout bent downward between the forelegs on the under surface of the body is at once recognizable as a Curculionid. Its color is pure milk-white, like the larva. The knees head, thorax, and anal segments are tufted with short bristle-like setæ. These are very short and minute, much shorter than in Conotrachelus, and arranged in pairs except on the thorax, where there are many. There does not appear to be any at the sides of the abdominal segments as in Conotrachelus. The length is about 4.5 mm.; the greatest width about half that.

A pupa is shown in its cocoon at *e* of figure 12.

Pupation takes place in a rather regular and compact oval cocoon, formed of particles of earth joined together, presumably by an adhesive substance, perhaps including a small admixture of silk. The cocoons are but slightly larger than the pupæ, measuring about 5 mm., and being about 3 mm. in diameter. They are formed a very slight distance, less than half an inch, below the surface of the earth, in the immediate vicinity of the infested plants. The pupæ rest within the cocoons, and these in turn lie in small earthern cells, from which they can readily be dislodged intact. They are sufficiently hard and firm to retain their shape after the issuance of the beetles.

BIOLOGIC LITERATURE OF THE SPECIES.

On the Eastern Continent *Ceutorhynchus rapæ* has apparently not attracted any attention as an injurious species, and the writer is unable to find in any of the more popular European publications any mention of its attacking useful plants.

Of its habits, Redtenbacher (Fauna Austriaca, Die Kafer, Vol. II, 1874, p. 347) says that the species "lives on *Cochlearia draba*, and in the larval condition in the roots of this plant. The mature larva goes into the earth and forms for pupation a small cocoon from the earth."

If there were any way of proving the identity of the species mentioned by Packard (l. c.) American biologic literature would begin with the publication of the note in question in 1872.

In the Annual Report of this Department for 1888 (p. 136), as previously noted, Miss Murtfeldt, formerly an agent of this Division, gave our first biologic account of this species under the heading "The cabbage curculio (*Ceutorhynchus napi*)," based upon its injuries to cabbage in hotbeds at Glasgow, Mo. The insect was stated to have injured over half of 40,000 plants, and some facts in its life history are contributed, including mention of its rearing several years before that time from larvæ boring the stalks of wild pepper-grass, *Lepidium virginicum*, as well as original descriptions of the egg, larva, and cocoon.

Injury is described as being shown by the puncturing and fretting of the plants in the crown and along the principal veins, a large proportion of the plants dying from this form of attack. The plants were stated also to be punctured in the center or at the side of the crown, and to contain a small white grub which was boring downward in the root, the soft castings filling the tunnel in its rear and being often forced out through the entering fissure. The year following, the same writer again called attention to injury by this species, mention being made under the name of *Ceutorhynchus rapæ*. Attention was also called to its appearance in the garden of Mr. F. M. Webster, at Lafayette, Ind., in May of that year (Bul. 22, Div. Ent., p. 73).

In 1892 the cabbage curculio was again reported injurious in Missouri by Miss Murtfeldt (Bul. 30, p. 50), when it was the occasion of "much loss and annoyance to market gardeners in some parts of the State by boring into the crown and roots of young cabbage and cauliflower plants, in many cases destroying 25 per cent of the plants in the hot beds and just after they are set out."

It was noticed at this time that the insects did not trouble the plants after the head began to form. From experiments conducted that year this writer became convinced that the insect returns to its original food plant, wild peppergrass, from the stems of which young larvæ were obtained in July.

In 1895 Mr. Webster gave a brief notice of injuries to young cabbage near Dayton, Ohio (Bul. 2, n. s., pp. 90, 91), and later furnished a more complete account (Bul. 77, Ohio Agl. Expt. Sta., pp. 50–52). In the Canadian Entomologist of March, 1896 (Vol. XXVIII, pp. 59–61), under the title "*Ceutorhynchus napi* or *Ceutorhynchus rapæ*," the same writer also published an article on this species, together with illustrations of the beetle, its larva and its work.

RECENT OBSERVATIONS ON THE BIOLOGY OF THIS SPECIES.

Upon opening a stem of hedge mustard, May 5, in the locality infested by the beetles on the Department grounds, no less than a dozen eggs were disclosed in the first inch and a half of the stem just beneath the flowers. They were resting in the pith, where they were inserted through punctures made in the stem by the rostrum of the parent beetle, the scar showing the place of deposit.

That the beetles appear much earlier, and egg deposition is consequently earlier than the first of May, was proved by finding in the same stem and in others toward the base numerous larvæ, some nearly full grown. Injury by this weevil to cabbage at Glasgow, Mo., as reported by Miss Murtfeldt, was noticed the latter part of April.

May 9, 1899, in a search for this species at Tennallytown, D. C., the beetles were found to occur but rarely on turnips, but were more abundant in the same garden in a bed of horse-radish.

At about this time it was noticed that the larvæ, as they approached maturity in hedge mustard, cut holes through the stalks, usually on the lower side of the axil of the branch or leaf-stalk. It was not ascertained just when the larvæ left the stems, but from the size of the openings toward the middle of May it is probable that some had already begun to desert the stems to enter the earth. Stems examined May 20 were found either to have been vacated or the larvæ were just completing their growth or preparing to cut their way out.

From what has been said of the number of eggs deposited in a stem it follows that many larvæ occur in a plant. Judging from some examined, sixty or more larvæ often find lodgment in a single stem and

its branches. Larvæ are found most numerous in the upper portion of stems, penetrating frequently as high as the diameter of the stem will admit them. They also bore into the branches, and occasionally a short distance into the leaf-stalks. In the upper portions the stem is often completely hollowed out toward the base, the larval tunnels growing much smaller.

In many cases the leaf-stalks are killed or so injured that they part from the stems when the latter are pulled up; and, again, the stems, being so closely tunnelled, often part above the middle, even dropping over, though not handled.

By the end of the month no larvæ could be found in any of the stems of hedge mustard examined, and on removing the earth from about the bases of the stems numerous cocoons were obtained. As a rule, weeds seldom suffer from the attacks of injurious insects as do cultivated plants; it is somewhat surprising, therefore, to find that quite a number of plants of hedge mustard had been so completely bored through in the upper parts of the stems that they cracked open, and the plant bent over at the point of fracture, and as a consequence the plants were in some cases injured so that the seed did not fully mature.

June 2 a second visit was paid to the garden at Tennallytown, D. C., and although the beetles had entirely vanished from our Department grounds, numerous specimens were found here upon seed turnip, as also larvæ in the stems of turnip and in the leaf-stalks of horse-radish. Affected plants of both turnip and horse-radish could be readily detected by the scars left by the puncture of the beetle and by the holes made by the larvæ, but it could not be ascertained what effect the presence of the insect had upon these crops, as the plants were plowed up when the place was next visited.

June 10 beetles of the new generation were observed, though rarely, on turnip at Marshall Hall, Md., this rarity being explained, at least in part, by the absence of native food plants in the vicinity.

During the next two weeks beetles were found at work on the leaves of cauliflower and cabbage on our experimental plats, being more commonly met with on the former plant, and nibbling almost exclusively along the edges of the leaves in much the same manner as *Phyllotreta vittata.*

THE NUMBER OF GENERATIONS.

It would scarcely seem necessary to devote any time to the subject of number of generations produced annually, since with scarcely an exception in the temperate climate of the United States the true weevils (Rhynchophora, exclusive of the Scolytidæ) are monogoneutic. Nevertheless the question has been raised. To ascertain the truth, beetles of the new generation were confined in a large rearing cage with healthy

potted turnip and cauliflower. On the leaves of the former they fed freely, but no punctures were made in the stems, and no eggs or larvæ were found in them, neither could they be found in hedge mustard nor cauliflower, upon which the beetles had been seen.

Owing to the difficulty in obtaining natural conditions for the curculios in confinement, the exact periods of the different stages were not observed; but from the facts ascertained we may deduce the life cycle with tolerable exactitude, reasoning from analogy, the ascertained data concerning other species.

SUMMARY OF LIFE HISTORY.

The following summary is based upon observations made in the District of Columbia upon the Department grounds:

The beetles make their first appearance some time in April and begin the depositing of their eggs, selecting by preference for the purpose wild-growing plants, such as hedge mustard. The parent beetle, after copulation with the male, punctures the stem of the host plant while the plant is still young, inserting her eggs in the holes made. It seems probable that oviposition begins some time about the middle of April, and continues at least a month, the parent insects practically all dying and disappearing by the end of May, as only one or two stragglers could be found by sweeping infested patches after that time.

The egg period will vary slightly, as do all the periods, according to the temperature, between five and eight days being the approximate time. The larvæ feed within the stems and larger leaf-stalks, and in about three weeks complete their growth, cut their way out, usually near where the leaf-stalks join the stem and enter the earth. Just beneath the surface of the earth they form little round earthen cocoons, and within these remain for about two weeks longer before forming the pupa. The pupal period is about the same as the egg, five to eight days, when the mature beetle is formed and cuts its way through one end of the cocoon and issues above ground. The first pupa observed was found May 20, and the first imago appeared June 3 in its cocoon. Within ten days later most of the beetles had made their appearance in the infested locality, all at this time being readily recognizable from the hibernating specimens by their darker tawny color. On the Department grounds none of the first or hibernated generation could be found at this time, consequently there was no overlapping of generation. The beetles had all deserted their wild plant by the end of the middle of June, but were still present on cauliflower and cabbage June 21.

A noticeable feature of the observations on the Department grounds was that cabbage, which was set out purposely in the immediate vicinity of the hedge mustard, showed no signs of infestation from the

hibernated generation, a fact which can be utilized in the control of this insect in the field, since if an abundance of the wild and preferred plants be available when the insects first appear it does not seem probable that cabbage would be attacked. In short, cabbage appears to be one of the last plants attacked in the field when any other palatable crucifer is obtainable. The beetles not only greatly preferred hedge mustard and wild pepper grass, but appeared to attack also, by preference, turnip, horse-radish, and cauliflower.

NATURAL ENEMIES.

One would suppose from the habit of the larva of this species of living within the stems of its host plant that it would not be particularly susceptible to parasitic or predaceous enemies, and such is probably the case. The adult insects are so minute and inconspicuous, and drop so readily from their food plants when disturbed, that they are probably not often attacked, and the cocoons are very seldom invaded by predaceous insects. Nevertheless the larvæ are sometimes killed by other insects. After a larva has made a hole in the stem, small as it is, ingress is afforded to natural enemies. In a stem of horse-radish growing in a spot where other larvæ of this species were found at Tennallytown, D. C., the pupa of a Chalcidid parasite was discovered, together with a portion of the head of the larva, leaving no doubt as to parasitism of the species. The adult issued June 5, and proved to be *Omphale livida* Ashm., the same species reared from the lepidopterous borer of Lima beans, mentioned in the discussion of that species. It was originally described from Florida in 1886 (Trans. Am. Ent. Soc., Vol. XIII, p. 135) under the genus Oxyomorpha.

METHODS OF CONTROL.

From what we have learned of the life history of this species it would appear that our principal reliance in its treatment lies in adopting preventive measures rather than in the use of insecticides. It seems quite probable that injury to hothouse plants of the nature which has been recorded may have been due to the introduction of soil in which the beetles were hibernating.

The utilization of wild food plants as a trap crop, etc.—If, as happened on the Department grounds the past year, the insect on its first appearance finds an abundance of its wild and preferred food plant, cabbage or other cruciferous crops of the vicinity are not apt to be affected to any observable extent. In localities where an invasion of this beetle has once occurred, it will be well to kill the insects by pulling up and destroying their wild food plants—not early in the season, but as soon as the adults have deposited their full quota of eggs and before the larvæ have left the stems. The proper time for this measure of

control would be before the middle of May in a climate such as that of the District of Columbia and about the middle of June in the Northern States.

Hot water; bisulphide of carbon.—In case some of the larvæ have escaped before this operation is carried out, they can be killed in their cocoons by drenching the earth about the plants with hot water. The insects can be destroyed in hothouses in the same manner, as advised by Miss Murtfeldt. If the degree of infestation does not justify the use of hot water owing to the danger of killing the growing plants, bisulphide of carbon could be substituted and injected into the ground by means of a McGowen injector, or some similar syringe in use for that purpose, or by simply pouring it about where the cocoons are found.

Arsenical poisoning.—The beetles, as previously stated, consume quite a quantity of the tissue of the plant and feed about the edges of the leaves in the same manner as do the cabbage flea-beetles. Where it is found necessary to protect cabbages against cabbage worms and other leaf-feeding insects, the Paris green or other arsenical used for the purpose will also kill this curculio, and no other remedy should be necessary.

Other measures.—We should, however, avoid taking earth into the greenhouse at a time when it is liable to be infested with these insects, and particular attention should be observed that it be not taken from the vicinity of cruciferous weeds. If the earth be sterilized, the heat would kill the curculios or other insects which it might contain.

It should be unnecessary to add that when the plants are found to be badly infested they should be pulled up when their loss seems assured and burned with their contained larvæ. The application of kainit or other fertilizer about the roots of less infested plants would assist these in recuperating from attack.

REMARKS ON THE FOOD HABITS OF SPECIES OF CEUTORHYNCHUS.

Forty-seven species of the true genus Ceutorhynchus, as at present restricted, inhabit America north of Mexico, but the habits of only a few of them are definitely known. Such of these as have been studied live in their larval state on the Cruciferæ.

EUROPEAN SPECIES OF CEUTORHYNCHUS.

On the Eastern Continent species of this genus inhabit also plants of other orders. In Europe alone 176 species have been recognized (Catalogus Coleopterorum Europæ, 1891). Of these, Bargagli (Rassegna Biologica di Rincofori Europei, pp. 255–267) has recorded biologic observations on 58 species, and in all save in a few cases mentions the food habits.

Among the European species of Ceutorhynchus which are enemies

of cultivated plants of the mustard family *C. sulcicollis* Gyll. and *C. assimilis* Payk., known respectively as the cabbage gall weevil and the turnip weevil, are the most important and receive mention in most economic works published in Europe. They injure alike cabbage, kale, rape, and turnip.

C. roberti Gyll., according to Rupertsberger (Verhdl. zool.-bot. Ges. Wien, 1887, Vol. XX, pp. 837–839), has similar habits to the cabbage gall weevil attacking *Raphanus raphanistrum* and rape.

The above three species, together with *C. cyanipennis* Ill. and *C. quadridens* Panz., which will be shortly mentioned, are included in a consideration of the crucifer-feeding Ceutorhynchus in Taschenberg's Insekten-Kunde (Vol. II, pp. 161–166).

C. contractus Marsh., the charlock-seed weevil, is recorded to do injury to turnip in England (Curtis's Farm Insects, p. 106).

C. napi Gyll., like *C. rapæ*, is not mentioned in any European popular economic works consulted, although both Goureau and Taschenberg have made reference to injury by it to both cabbage and colza or summer rape.

THE SEED-STALK WEEVIL.

The question of the proper nomenclature, or more strictly speaking identity of the cabbage curculio of North America with the European *Ceutorhynchus rapæ* led to some further study of certain other forms, with the result that a species treated by Mr. F. A. Sirrine (Rept. N. Y. Agr. Expt. Sta. for 1895, p. 603), and identified as undescribed by Dr. Dietz, proves with little doubt to be identical with a European species, *C. quadridens* Panz. This species was given the name of *C. seriesetosus* and described on page 422 of the Transactions of the American Entomological Society for 1896.

The occurrence of this insect in America is evidently of very recent date, the specimens received by Mr. A. Bolter from Nantucket, Mass., appearing to be the first collected, and at the present writing there is no further knowledge of the insect's distribution than that it occurs in the locality mentioned and on Long Island in the vicinity of Cutchogue. It appears to have been first noticed on Long Island in 1895.

The exclusive occurrence of this species only on our Atlantic coast, close to our great shipping ports, as well as the fact that thus far it is known to attack only cultivated plants, although searched for on others, led to the suspicion by Mr. Schwarz and the writer that it might be a foreign importation and of recent introduction. Mr. Sirrine has kindly sent a series of specimens of *C. seriesetosus* for examination, and Mr. Schwarz has now ascertained from comparisons with descriptions and European specimens that the species is doubtless identical with the European *C. quadridens* Panz., a common and widely distributed insect in its Old World home.

Ceutorhynchus quadridens was given its specific name by Panzer in 1796 (Faunæ Germanicæ, Heft. 36, p. 13).[1]

The first biologic account appears to be that given by Colonel Goureau in 1866 (Annales de la Société Entomologique de France, Vol. VI, p. 171). This is in connection with its development from larvæ living and feeding within the roots of "navette," or rape (*Brassica napus*).

Redtenbacher (Fauna Austriaca, Vol. II. p. 344) has mentioned its occurrence on the same plant in Austria, and Bargagli (l. c., p. 264) states that the beetles are found at Florence in April on the flowers of *Cochlearia armoracia* (horse-radish), also upon cavolo (cabbage). To this list Perris (Larves de Coléoptères, 1877, p. 408) adds as food plants mustard (*Sinapis nigra*) and watercress (*Nasturtium officinale*).

Writing November 17, 1899, Mr. Sirrine said that he could easily see how this pest might have been imported with the seed of cabbage, kale, or turnips, as the adults issue on Long Island, in the neighborhood of Jamaica, before the seed is gathered. The reason why the species has not been observed in other sections of the island, however, where the seed-growing industry is not followed, is not so clear, but our correspondent assumes that the beetles can not obtain a foothold in sections where the above plants are grown merely for marketing, in spite of the fact that in most neglected fields wild radishes and various wild mustards and other cruciferous plants grow which ought to furnish suitable food for the beetles in all portions of the island.

This species will be seen to differ at once from the cabbage curculio by its smaller size, being about a tenth of an inch in length; by its subtrapezoidal form, and by the colors of its scales. These are white and intermixed with gray hairs, the whole forming a somewhat indistinct pattern, whereas *rapæ*, it will be remembered, is uniformly gray or fulvous. The scutellar spot is prominent and the elytra are marked by strong rows of erect setæ.

CEUTORHYNCHUS CYANIPENNIS GERM.

What appears to be the first record of the occurrence of this species in America is by the late William Juelich, in volume V of Entomologica Americana (March, 1899, p. 57), in a note in which he refers to a series of specimens taken by the writer at Ithaca, N. Y., and to others found by Dr. Otto Lugger at Baltimore, Md. The writer first observed this species about 1879, but there were at that time in the collection of the Cornell University a series of this weevil taken in the same region in the early seventies, and as near as can be remembered in 1873.

[1] It was afterwards redescribed under the same name by Gyllenhal (Schoenherr's Genera et Species Curculionidum, Vol. IV, p. 534), and later by different authors under the names *boraginis* Gyll., *calcar* Panz., *pallidactylus* Marsh, and *quercicola* Marsh.

Mr. H. F. Wickham has recorded this species from Idaho, Dr. Hamilton (Trans. Amer. Entom. Soc., Vol. XXI, p. 405) records it from Illinois, and Dr. Dietz (l. c., p. 31) states that it occurs also in California.

C. cyanipennis can be readily distinguished from any other Ceutorhynchus occurring in this country, except *C. bolteri* Dietz, by its color alone. Its elytra are steel blue, hence the specific name. It is larger than *bolteri*, and has toothed claws.

In Bargagli's reference to this species (l. c., p. 259) he gives *sulcicollis* Gyll. as a synonym, but *C. sulcicollis* Payk. is distinct. He refers to its occurrence on *Sinapis arvensis*, *Capsella* (*Bursa*) *bursa-pastoris*, *Achillea millefolium*, cabbage, rape, and horse-radish, giving references in full for food plants, as well as for notes on the larva and its habits.

Although this species has been established in America for a great many years, it has yet to be found attacking useful plants; in fact, to the best of the writer's knowledge, no food plant has been observed in this country.

FOOD HABITS OF NATIVE SPECIES OF CEUTORHYNCHUS.

Ceutorhynchus septentrionis Gyll.—At the same time that the cabbage curculio was observed on the Department grounds on *Sisymbrium officinale* during the first week of May, 1899, the beetles of this species were found, but not in the same abundance, in a truck garden at Tennallytown, D. C. They occurred in much greater abundance than the cabbage curculio, being particularly numerous in a large bed of horse-radish and comparatively rare on cultivated mustard. May 13 beetles were found by the score on single plants of yellow rocket (*Barbarea barbarea*) at Rosslyn, Va., occurring on every plant examined.

C. adjunctus Dietz, from Utah and Nevada, has been collected by Mr. Schwarz, on a species of Stanleya.

C. hamiltoni Dietz has been found in Massachusetts on the maritime plant sea rocket (*Cakile americana*).

ADDITIONAL NOTES ON THE IMPORTED CABBAGE WEBWORM.

(*Hellula undalis* Fab.)

Since the article on the imported cabbage webworm, *Hellula undalis* Fab., was published (Bul. 19, n. s., pp. 51–57) a number of facts have been ascertained that are new and that bear upon the biology, distribution, and probable origin of this species. An additional economic article on this insect, by Mr. W. M. Scott (Bul. No. 1, Georgia State Board of Entomology, April, 1899, pp. 17–25), has appeared, and the writer has obtained access to three recently published works treating of this species which were not before available. The insect has been carried through its several stages, and this, with the descriptions of the

egg and first larval stage, will practically complete the account of the life stages as well as can be accomplished by office experiment alone.

From latest information it appears that injury by this webworm was first detected in the United States in 1895, and from what is known of introduced insects in general it may be conjectured that it was introduced at a considerably earlier period, probably several years prior to the date mentioned, as it often requires a number of years for a species of insect to become established after its arrival in a new country.

The receipt of specimens from other sources and the reports of injuries in new localities go to show a much wider distribution for the insect than credited hitherto. Its occurrence, as now ascertained, in South Carolina and Alabama renders it more than probable that it already ranges throughout the Gulf region, although as yet perhaps not in troublesome abundance, except in the States mentioned and in Georgia.

In the other works to which reference is made, and which will later on be cited, considerable is added to our knowledge of the insect's foreign distribution; in short, it is shown that the species is already cosmopolitan and evidently rapidly widening its range.

ADDITIONAL LITERATURE OF THE SPECIES.

As a result of our first article, we received a communication from Mr. Arthur M. Lea, Government entomologist, Department of Agriculture, Hobart, Tasmania, who wrote under date of June 27, 1899, that this species occurs in very destructive numbers in western Australia. While entomologist to the agricultural department of that colony he published several notes on the species, which he describes as being the worst of all cabbage pests. The species was unfortunately referred to as *Evergestis rimosalis*, but subsequently specimens were identified by Mr. Otto Lower, an Australian microlepidopterist, as *Hellula undalis*. One of these notes is published in the Journal of the Bureau of Agriculture, volume IV, page 1420, issued at Perth, West Australia, December 1, 1897.

In the article referred to, which is the only one of Mr. Lea's that is accessible at the present writing, the insect is called the "stinking-head moth." Two characteristic appearances are described as being due to the work of the larva, called, respectively, "stinking-head" and "balloon head," the latter being figured. "In damp, rich soil the heart becomes a blackish crust, beneath which is a slimy, stinking fluid swarming with maggots and various insects. In drier soil the outer leaves drop off, the head dries and becomes balloon-shaped, and the larval excrement may be seen on the stem and crown; the latter may be knocked off at a touch; whole rows can be seen that have been so destroyed."

The remaining publications will be mentioned later on under the head of notes on distribution.

The various accounts of the method of attack, and particularly of the feeding of the larvæ reported by correspondents and recorded by others, do not agree in every detail.

EARLY APPEARANCE OF THE INSECT IN SOUTH CAROLINA.

Through an unfortunate oversight an earlier rearing of this pernicious webworm was overlooked and hence not recorded.

August 10, 1896, we received from Mr. H. M. Simons, Hayfield Farm, Charleston, S. C., larvæ and pupæ, with the statement conveyed in a letter of August 6 that the species was very destructive to young cabbage in that vicinity. Our correspondent had planted cabbages for many years and had first noticed this insect in 1895, when only a few were seen. At the time of writing it was estimated that $100 worth of plants had been lost on account of the webworm. Many of our correspondent's neighbors had lost all their cabbage plants, and this in spite of tobacco water and Paris green, the latter applied both dry and in liquid form. The moth was stated to lay its eggs on the upper side of a leaf, and the young larva upon hatching entered the leaf and ate between the inner and outer sheaths, working gradually downward.

Mr. N. L. Willet, Augusta, Ga., who furnished information concerning this species and its occurrence in his vicinity in 1898, again sent specimens the present season with accompanying letter of August 29, and the information that it was only then being noticed by its ravages in that county. Not very much harm had been done at that time, and our correspondent was of the opinion that the insect was later in its appearance than in the previous year. In short, it was difficult at that time to find larvæ, the truckers of the vicinity declaring that they could not obtain the "worms" at all.

September 12 we received another sending from Mr. Simons, with the statement that the insect had done a great deal of damage to young turnip plants. It was noticed that the larva in our rearing cages fed on the common shepherd's purse, *Bursa* (*Capsella*) *bursa-pastoris*. In the letter accompanying this last sending our correspondent stated that in all his years of farming he had never seen such complete and utter destruction of any crop as by this little insect. He wrote that it attacked plants in all stages of growth; turnips just after they were clear of the ground. He had lost his entire planting of cabbage, the seed alone of which was worth $40.

NEW LOCALITIES IN GEORGIA AND IN ALABAMA.

Mr. W. M. Scott wrote September 2, 1899, concerning the occurrence of this moth in his State saying, among other things, that he had received specimens from Tifton, Ga., a locality not previously mentioned, and that the pest was injurious that season as also in former years. Owing to the crop about Augusta being so badly infested last season, the truckers there planted scarcely any turnips the present season, and for this reason, probably, the cabbage webworms were not noticed to be very numerous in that vicinity. On an experimental plat of Mr. Scott's at that place, however, these insects appeared to be as numerous as last year.

September 9, 1899, Mr. F. S. Earle sent specimens of the larvæ of this species, with the accompanying information that it was injurious to turnip seedlings at Auburn, Ala., and had been very troublesome for the past three seasons, its presence being noticeable in the fall of the year. The species was stated to have practically ruined the turnip crop in many gardens.

September 11 Mr. Thomas I. Todd, Athens, Clarke County, Ga., wrote of the appearance the past summer of this webworm, which he described as very destructive on cabbage, turnip, etc., and September 18 specimens of the insect were received from the same correspondent. Our correspondent stated that turnips once infested by being attacked at the bud never made good growth afterwards. The species was referred to as the "Augusta webworm." The caterpillars were stated to form their webs on one side of a plant near the surface of the ground or under the end of a leaf resting upon the ground. Our correspondent had kept two hands employed since the 22d of April dusting the plants nearly every day with poisons and searching for this particular caterpillar. The loss sustained by him was placed at not less than $250. During that season 50 pounds of Hammond's slug shot were used in one week without apparent benefit, and Mr. Todd stated that if he could not check this webworm he would have to abandon the raising of cabbages and turnips. Paris green applied in the usual manner, dusted on the plants, was tried twice each week without much effect. Two acres of turnips were so badly infested that they had to be plowed under.

NOTES ON DISTRIBUTION ABROAD; SYNONYMY.

As the appearance of the species in the vicinity of Augusta, Ga., the only other locality besides Los Angeles, Cal., in which it was positively known to occur in this country at the date of publication of the writer's first article, does not appear to have been observed prior to August, 1897, it seems probable that it was first introduced in the region where now established in South Carolina and Georgia, near Charleston, and at least as early as 1895, and from there has spread to

the neighborhood of Augusta. Near Auburn, Ala., it has been known since 1897.

Of the distribution of this species, Sir G. F. Hampson, in volume IV of the Fauna of British India, published in 1896 (p. 373), says: "Mediterranean subregion and throughout the tropical and subtropical zones, except the neotropical and Australian regions." From this and the fact that the insect does not inhabit northern or middle Europe, it would appear that there is no immediate danger of its appearance in the region of our country north of the Lower Austral area.

In the same writer's Revision of the Moths of the Subfamily Pyraustinæ and Family Pyralidæ, (Part I, p. 760), from the Proceedings of the Zoological Society of London, November 15, 1898, *Botys rogatalis* Hulst. is added to the list of synonyms, with this legend in regard to distribution: "U. S. A.; Mediterranean subregion; Ethiopian and Oriental regions."

The following synonymy is recognized:

Hellula undalis Fabr., Ent. Syst., Vol. III, 2, p. 226, Herr.-Schäffer, Eur. Schmett., Vol. IV, pl. 8, f. 54.
Scoparia alconalis Walker, Catalogue, Vol. XIX, p. 827.
Leucinodes exemptalis Walk., Catalogue, Vol. XXXIV, p. 1313.
Botys rogatalis Hulst., Tr. Am. Ent. Soc., Vol. XIII, p. 149.

In the publication first cited will be found a technical diagnosis of the genus Hellula, as also a technical description of the species. Both publications are illustrated. The figure, showing wing venation and head, are here reproduced.

OBSERVATIONS OF THE YEAR 1899.

June 19, 1899, in response to request, Mr. Simons wrote that the moth had made its appearance in his garden, and sent us the first specimens seen. The moths are very rapid in their movements when in the field, and for that reason, difficult to capture. Cabbages had been almost a total failure in 1897 and 1898, owing to the ravages of this pest.

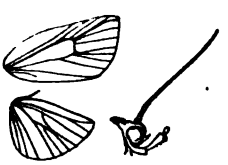

FIG. 13.—*Hellula undalis:* wing venation, head and antenna—enlarged (after Hampson).

Decrease in numbers owing to cold winter.—Of the noticeable decrease in the numbers of this insect in the early summer of 1899, our correspondent wrote, July 22, in response to our suggestion that the climatic conditions were probably in great part the cause of the decrease, that the previous winter, as with us at Washington, was unusually severe, being marked with snaps of intensely cold weather. This, in our opinion, as previously expressed in Bulletin No. 22 (n. s., p. 56), would be just the sort of weather to destroy an insect which is not as yet thoroughly acclimatized, since such sudden changes and severely cold spells are never experienced in the Old World regions which this insect is known to inhabit. The same conditions doubtless

operated at Augusta, Ga., where the species was rare, till late in August, as previously stated.

An unrecorded wild food plant.—In response to inquiry, Mr. Simons stated that this webworm was first noticed on "pussley," or "cutter grass," otherwise purslane, *Portulaca oleracea;* it was then noticed on cabbage beds, and afterwards extended its ravages to fields of cabbage and other crucifers. In confinement at this office larvæ readily fed upon purslane.

Mr. Simons writes that the larvæ feed upon the inner portion of the leaves of young cabbages between the inner and outer integuments or skins of the leaf, and that, when nearly full grown, they usually spin up a web about the heart of the plant which they enter. Specimens of young cabbage plants received about that time showed that larvæ had entered the head singly and bored down into the stalk, their presence there being manifested by webbed-up masses of dark excrement.

In our rearing cages the larvæ fed almost exclusively on the under surface of young cabbage, the youngest eating away the epidermis and parenchyma in small irregular patches, leaving one eroded space and attacking another place, very often crawling in at a hole, which they gnaw, and feeding, as our correspondent describes, between the two outer integuments. As the larvæ grow larger, at about the first molt, they begin to cover their work with webbing, and this, with the excrement which adheres to it, forms a more or less perfect place of concealment for them.

APPROXIMATE LIFE HISTORY.

From the material received from South Carolina the moths obtained by rearing served as a basis for the completion of the life history of the species as nearly as this could be done without visiting the premises where infestation occurred.

From the received larvæ, of what is at present considered the first generation of this species, moths were obtained July 22, the approximate date of the appearance of the second brood of the insect. A very considerable number of the remainder issued a few days later. A number of the moths of this lot were placed in a rearing cage July 24, when egg deposit began. The ascertained period of the egg at this time, as was previously stated, was three days. Pupæ were first obtained August 14, which gives eighteen days as the larval period. The pupal period lasted six days, which brings the entire life cycle for this time to twenty-seven days. The weather for this period was seasonably hot, and this is not far from the minimum period that would be required for development in the Southern States also.

THE EGG AND OVIPOSITION.

A pair of moths newly bred were placed in a vial July 24, and next morning the female was found to have deposited singly, doubly, and in masses of from 3 or 4 to 20, a total of 235 eggs. The following day 24 were laid; on the 27th, 37 were found, or 296 in all. Afterwards the moth died, having laid no more. A few eggs were found upon dissection, making the probable number usually deposited between 300 and 350.

Most of the moths die in confinement within a week.

The egg.—The egg is of sufficiently large size, about four one-hundredths of an inch in length, as to be readily discernible to the naked eye. It is of oval form and rather variable in contour, being usually more or less flattened upon the surface of deposit, and there is often a distinct nipple at one extremity. Its greatest width is about three-fifths its length. The color when first laid is light gray, and under a strong hand lens the surface appears to be rugose and strongly iridescent. Under a higher power the surface is found to be made up of depressed irregular areas, mostly hexagonal and pentagonal in outline.

Length, about 0.5 mm.; greatest width, 0.3 to 0.35 mm.

A day after deposition the eggs begin to take on a pinkish hue, due to light reddish spots below the surface. On the second day the embryo can be detected, the head showing as a blackish dot near one end and on the lower surface of the egg or the side of attachment.

Experiments conducted in the latter days of July, in a temperature officially rated by the Weather Bureau of this Department as moderate (indoor 80° to 84° F.), showed that the eggs hatched three days after deposition, a rather remarkably short period for a moth with a wing expanse of nearly three-fourths of an inch.

THE NEWLY HATCHED LARVA.

The larva when just hatched measures about a millimeter in length and about a twelfth that in diameter across the abdomen. The head, as is usual with young larvæ, is prominent, wider than the body, and dusky in color. The thoracic plate is also dusky and of somewhat similar subcrescentic form to the more mature stage. The body is very pale yellowish gray, nearly white, and the surface is moderately clothed with long fine hairs.

Very soon after hatching the larva shows the characteristic striæ of the more mature form. Thus larvæ 2 mm. in length are so little different in general appearance from the full-grown ones as to be readily recognized as of the same species.

NATURAL ENEMIES.

Two new parasites of this webworm were reared during the year and have been identified by Mr. Ashmead as *Meteorus vulgaris* Cress. and *Temelucha* (*Porizon*) *macer* Cress. ♀., both hymenopterous. The former, an Ichneumonid, was reared in September from material received from Auburn, Ala.; the latter, a Braconid, issued during the latter days of July from larvæ received from Charleston, S. C.

The Tachinid parasite *Exorista pyste* Walk., previously mentioned as an enemy of this webworm, was reared October 6 from the South Carolina lot, received in 1896, and recorded in Technical Series No. 7, of this Division, page 14, although the host was not known at that time by its specific name. An effort was made to ascertain the past year if any new species of parasitic or predatory insects were useful in destroying this webworm, but none of the several lots of larvæ which were sent from different localities and kept in our rearing jars for the purpose were parasitized. It is quite probable that in the course of time many of the various known parasites of other crucifer-feeding caterpillars will be found to attack this webworm, but for this we may have to wait perhaps for several years before parasitic or other natural enemies will be of any service as mediums for its reduction.

REMEDIES.

At the present writing nothing new has developed in the line of methods of control. It is suggested, however, that in view of the unusual destructiveness of this insect that some such methods as are in use against the striped cucumber beetle be employed, for example, the planting of an excess of seed with the aim of afterwards destroying those plants which are injured by this webworm beyond redemption.

Cabbage and turnip appear to be the favorite crop plants affected, though collards and radishes are also attacked; and it seems probable that these could be advantageously used for the protection of beets and vegetables other than Cruciferæ, which future observations will probably show are affected by the insect. The trap crop should be freely sprayed with Paris green, and the main crop could be sprayed with kerosene emulsion. Mr. Simons writes that a mixture of kerosene oil and soap sprayed upon the plants served as a deterrent against the moth, but that they returned as soon as the odor of the kerosene had become dissipated. Kerosene emulsion properly prepared and applied often enough to insure a permanent odor should be effective.

One point must be emphasized if we expect to meet with success in combating this insect, and this is that work must begin upon the first appearance of the insects each season, as what is done then will very materially affect injury for the entire year. Injury might be considerably lessened if a practice were made of pulling up and destroying

all badly infested plants before the issuance of the first new brood of moths. From current reports during the year it would seem that the proper time to begin this work is about the middle of July, as the larvæ are then nearly mature and the moths appear soon afterwards.

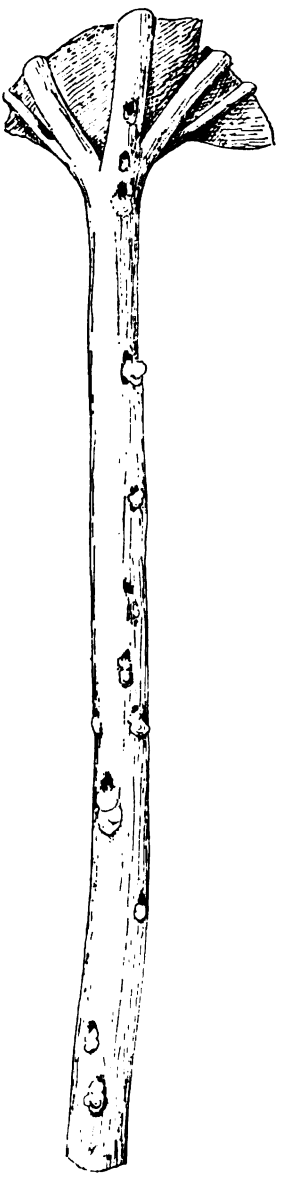

FIG. 14.—Stalk of rhubarb injured by *Lixus concavus*—reduced one-fourth (original).

THE COMMON RHUBARB CURCULIO.

(*Lixus concavus* Say.)

Residents of the Eastern States who are familiar with the appearance of growing rhubarb or pieplant (*Rheum rhaponticum*) can not fail to have noticed that stalks here and there are often injured, so that the juice exudes and, drying, forms clear tear-like drops. Closer examination will show that these drops exude from holes gnawed by an insect, and if one should seek the culprit he will not be long in tracing the cause to a large rusty-coated, long-snouted beetle known as *Lixus concavus* Say, and which we may call the common rhubarb curculio to distinguish it from another closely related species, *L. mucidus*, which has similar habits.

May 9, 1899, the great numbers of beetles of *Lixus concavus* in a plat of rhubarb at Tennallytown, D. C., attracted the writer's attention and led to further study of its life economy and the preparation of the present paper. Almost every stalk of rhubarb had been attacked and some so badly as to interfere with their sale, at least to many would-be purchasers. One of these stalks served as the model of the illustration here presented as figure 14.

According to the published statement of Mr. F. M. Webster (Proc. Ent. Soc. Wash., Vol. II, p. 339), the insect treated by Dr. C. M. Weed in publications of the Ohio Agricultural Experiment Station (Bul. No. 6, Vol. II, p. 153, and Bul. No. 8, Vol. III, 2d series, pp. 232–235) under this name is not the true *concavus*, but *mucidus*. The investigations which have been conducted during the year, however, indicate that this is a matter of scientific

interest rather than of economic importance, as the two species show close similitude in the details which go to make up their life histories.

DESCRIPTION OF THE SPECIES.

The adult.—The adult or mature form of this insect is a snout-beetle or curculio of the typical rhynchophorus family, Curculionidæ. It is one of the largest species of its kind, measuring from the tip of its long snout about three-fourths of an inch in length and is about three-sixteenths of an inch in width. The body and head together are about five-eighths inch long and the snout nearly three-eighths. The snout is cylindrical, black in color, and grooved on the sides for the reception of the scape of the antennæ. From other related genera the species of Lixus may be distinguished by the pollinose substance with which their bodies are covered. The covering of

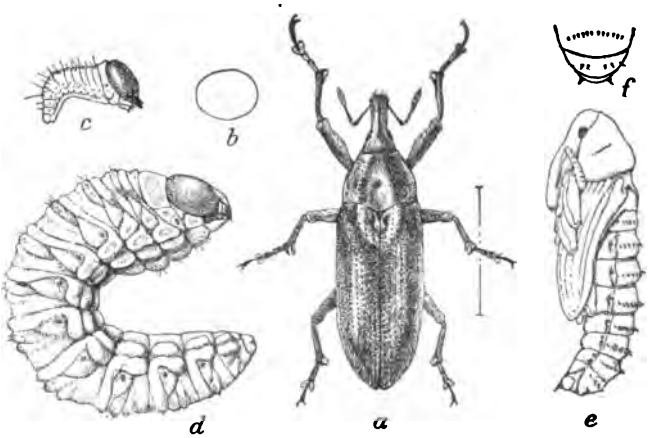

FIG. 15.—*Lixus concavus: a*, beetle; *b*, egg; *c*, newly hatched larva; *d*, full-grown larva; *e*, pupa in profile, showing dorsal motorial spines; *f*, dorsal view of last abdominal segments of pupa—all about twice natural size (original).

Lixus concavus is very bright yellow, and the writer has kept hibernated specimens for two or three months that retained this pollinose covering, which he considers pubescence. It readily rubs off, however, when the insect is handled. The elytra are of remarkably firm consistence, so hard, in fact, that it is difficult to impale the beetle with an ordinary insect pin. From other species of the genus, *concavus* is to be distinguished by the deep triangular concavities at the bases of the thorax and elytra. The prothorax is just perceptibly wider than long, moderately rounded at the sides, and distinctly constricted apically.

In the male the snout is shorter and the antennæ are inserted about one-fourth from the apex, while in the female they are placed about one-third from the end. The female is represented in figure 15 at *a*.

Lixus mucidus, the only other species known to attack rhubarb, is

larger and more robust, with stouter snout. The body is clothed with fine gray pubescence.

DISTRIBUTION.

LeConte and Horn merely credit this species to the Atlantic district. From specimens in the National Museum and other local collections and from published and divisional records the following list of localities is taken:

Stratford, Conn.; Buffalo, Ithaca, Long Island, New York, N. Y.; "more or less common throughout the State" of New Jersey (Smith); Blooming Valley and elsewhere in Pennsylvania; Columbus, Ohio; District of Columbia; Cabin John, Marshall Hall, River View, and Travilah, Md.; Rosslyn, Va.; Cadet and elsewhere in Missouri; New Ross and Lafayette, Ind.; Detroit and Port Huron, Mich.; Lawrence, Kans.; Iowa City, Iowa (Wickham); Retreat, N. C.; Lake Ponchartrain (Summers) and elsewhere in Louisiana; Minnesota (Lugger); Grimsby, Ontario, Canada (Pettit).

This is a surprisingly short list of localities considering how common the species is known to be. It is obviously an Austral, or, more properly speaking, Carolinian, form, being found apparently in much greater abundance in the Upper than in the Lower Austral life zone. It also occurs in the Transition, but in the Transition of the Middle West, as for example in northern Illinois, it is replaced to a considerable extent by *L. macer*, while in Texas it gives place to *L. læsicollis* and other species. Its known western range does not extend beyond the Mississippi Valley.

DESCRIPTIONS OF THE EARLIER STAGES.

The egg.—The egg is of somewhat variable oval form, the usual proportions of width to length being about four-sixths, the extreme reaching five-sixths; surface smooth, polished, with no visible sculpture; color dull, pale yellow; contents completely filling the shell, leaving no translucent spaces at ends; consistency of moderate firmness. Length, 1.50 to 1.90 mm.; width, 1.25 to 1.30 mm. An egg is shown in outline in figure 15 at *b*.

The newly-hatched larva.—The larva when just hatched presents the appearance of *c*, figure 15. The head is extremely large in proportion to the remainder of the body, the mouth-parts, particularly the mandibles, being especially prominent.

The mature larva.—The larva when full grown appears as shown at *d*. It measures, when in the curved position common to the Curculionidæ and shown in the figure, about 10 mm. When fully extended the length is about twice that, 21 to 23 mm., according to Webster. The width is between 4 and 5 mm. It is of nearly cylindrical form,

flattened on the extreme ventral surface. The color is milk white, the head being light brown and the mandibles dark brown, nearly black. The first thoracic segment is marked with a light yellow transverse chitinous patch resembling the cervical shield of many caterpillars. The head is nearly circular in outline, and is ornamented by an inverted Y mark. The mandibles are short and strong, concave on the inner surface, and bidentate at the tips. The leg pads are moderately prominent, and rather sparsely covered with short yellow bristles. With the assistance of the figure a more detailed description may be dispensed with. Full descriptions both of larva and pupa have been published by Mr. Webster in his article in Entomologica Americana (Vol. V, p. 14).

The pupa.—The pupa shown in the illustration at *e* in profile is of the same white color as the larva. It is somewhat remarkable on account of the row of retrorse spines on the back of each abdominal segment. The first or cephalic row consists of shorter and finer spines, and the last row of only four, in pairs on each side of the middle (see fig. 15, *f*). The terminal segment ends in two spinelike processes on the ventral side. The length is 14 to 15 mm.

The pupa cells are broad and ample, varying somewhat in length from two to three or four times the length of the pupa itself. Cells before the writer measure from 5 to 7 mm. in width and from 25 to 40 mm. in length. By means of the rows of spines on its back the pupa is enabled to work its way readily up and down from one end of its cell to the other.

The majority of the cells examined were constructed just beneath the surface of the earth, the top of the cell lying level with the earth's surface. Cells often, therefore, extend into the roots and appear to be deepest where the plants are short and dry, and dry up early. No special point appears to be selected by the larva for gnawing away an exit place for the imago, but the stem is so weakened near the bottom of the cell that it breaks at this point if pulled, and it doubtless cracks and breaks in time with the drying of the plant, so that the beetle when fully matured and ready for exit has no difficulty in effecting its escape.

BIOLOGIC LITERATURE.

For so common an insect as is this curculio, published accounts bearing on its habits and life history are few in number.

The first notice of its food habits is that given by Townend Glover in the Report of the Commissioner of Agriculture for the year 1865 (1866, p. 90). Reference is there made to the beetle having been observed "burrowing into the footstalk of the rhubarb or pie plant and then depositing a single egg in each hole." No larvæ were reared, but the opinion was expressed "that if the yellow decaying leaves of the

rhubarb were examined many of them would be found to have been injured by this insect." Five years later the same writer, in his report as Entomologist (loc. cit., 1870 [1871], p. 71), gives another short account of this insect, with an illustration of the adult.

After the lapse of another five years Dr. George Dimmock (Standard Natural History, Vol. II, p. 343) refers briefly to the occurrence of the species on the dock *Rumex orbiculatus*.

Discarding the two articles of Weed for the reason previously mentioned, we come to the very full account of this insect by Mr. Webster, published in Entomologica Americana in 1889 (Vol. V, pp. 12–16). In this article wild sunflower (Helianthus) is mentioned as a food plant in central Illinois. The egg, larva, pupa, and oviposition are fully described, and other notes are given on the life history of the species. It is quite singular that larvæ in this case were found only in Helianthus, a genus of plants upon which the insect has not been observed by any other writer to my knowledge. On page 16 of the article referred to Mr. Webster states that in a single case he observed a female ovipositing in Silphium, or rosin weed, and states that the adults feed also upon the foliage.

In volume VI of Entomologica Americana (p. 169) the writer referred briefly to the occurrence of this species on a common broad-leaved variety of dock (Rumex) and less often on rhubarb.

In Mr. Webster's article on the food plants of the genus (Proc. Ent. Soc. Wash., Vol. II, pp. 339–341) nothing new is added of this species other than the correction referred to in the opening lines of this article.

DIVISIONAL RECORDS.

May 18, 1883, we received from Mr. J. G. Barlow, Cadet, Mo., a leaf of rhubarb showing punctures of this curculio on the midrib.

November 25, 1885, Mr. F. M. Webster sent from Lafayette, Ind., stems of Helianthus from which this insect was later reared.

May 19, 1887, we received from Mr. W. B. Alwood, then at Columbus, Ohio, stems of rhubarb in which this species had oviposited.

June 5, 1895, Mr. F. V. Braymer, Blooming Valley, Pa., sent specimens of the beetle discovered on the yellow dock. June 20 Dr. Homer Bowers, New Ross, Ind., sent beetles, with report that they were observed on the foliage of growing rhubarb.

July 26, 1896, Mrs. R. H. Russell, Stratford, Conn., reported finding this species upon a dwarf sunflower in her garden.

May, 1898, Mr. F. M. Webster reported receiving this insect, with a species of Sphenophorus or "bill bug," with statement that they were injurious to corn. We have also received similar reports, the beetles being included with Sphenophorus. This is merely mentioned to show that there is some slight similarity between the species of

Lixus and Sphenophorus, these genera being of about the same average size, but not at all likely to be mistaken by anyone who studies the subject of entomology.

FOOD PLANTS.

As already shown, this species does not develop in rhubarb. The only larval food plant observed by Mr. Webster in central Illinois and Indiana was wild sunflower, *Helianthus grosseserratus*, a common Western plant. In and about the District of Columbia, as well as in the vicinity of New York City and Ithaca, N. Y., this curculio was observed only on rhubarb and dock, and the latter is the favorite and apparently the only larval food plant about Washington. It is probable that all species of Rumex having suitable stems for the development of the larva are utilized for this purpose. The species from which the beetles have been reared are curled dock (*Rumex crispus*) and broad-leaved or bitter dock (*R. obtusifolia*).

Lixus concavus is the only species observed on Rumex or rhubarb in this vicinity.

The adult of this curculio feeds upon the foliage of all of the plants mentioned, usually by gnawing the edges of the leaves, but it seems probable that a considerable quantity of nourishment is also taken when the stems are punctured for oviposition, if indeed they are not often punctured, as seems most likely, for food alone.

THE INSECT'S LIFE HISTORY.

Hibernation and time of appearance.—This rhubarb curculio hibernates as a beetle in and near the District of Columbia, and is one of our early arrivals, appearing in the field some time in April, presumably with the appearance of its food plant, or about the time that the stems are large enough for oviposition. Pairing and egg deposit begin soon afterwards.

From the scarcity of beetles in the field after the dying out of the hibernating generation in the summer, the writer had formed the opinion that beetles overwintered in the stalks, and particularly because Mr. Webster had found that hibernation also took place in other stages (larva and pupa) in the localities where he had made observations. It was therefore surprising that in spite of several attempts, made at intervals between the second week of September to the second week of October to find beetles, none could be found in stems in which there was evidence that they had developed.

A beetle that issued August 12 was kept for upwards of two months without food. October 18 a beetle was captured in the field that had evidently been flying, and this, together with the beetle reared in confinement, were placed in a jar with dock leaves October 18. The latter

died in a day or two without feeding, while the other fed freely in the accustomed manner on the edges of the leaf.

Everything considered, this is tolerably good evidence that, in spite of the rarity of the beetle of this species in the field or the difficulty of finding it in autumn, it does, at least occasionally and perhaps normally, issue from its burrows to feed before seeking a new place for hibernation.

ON THE HABITS OF THE SPECIES.

The eggs are deposited singly in little oval or elliptical cavities measuring about 2 mm. in width and 4 or 5 mm. in length, and constructed in the stems at a depth of between 2 and 3 mm. beneath the skin. In thin stems of dock the egg is deposited loosely through the hole made by the parent beetle in the hollow of the stalk.

FIG. 16.—Section of stalk and of leaf of rhubarb, showing attack of *Lixus concavus*—natural size (original).

Egg deposit evidently takes place by preference in the young flower-stalks, but as it is the custom of many gardeners to cut these off early in the season, the beetle is forced to lay her eggs in other parts of the plant; hence it follows that eggs are quite as often found in the main stems, the crown of the plant, and even in the larger veins of the leaves. A great many more punctures are made in the stems of rhubarb, particularly early in the season, than are necessary for deposition of eggs. In the section of rhubarb stalk illustrated at fig. 16, taken from the field in early May, all of the punctures appear to have been made either for food or else the insect was deterred from depositing her eggs by the presence of too copious exudations of juice.

In dock the egg punctures occur from near the bases of the stems far toward the tops, and nearly always contain eggs or larvæ. Dock stems sometimes contain as many punctures as in the rhubarb stem of the figure. Later in the year, even by the first week of June, eggs are nearly as often found in rhubarb, particularly in the flower-stalks.

The species of Lixus are long-lived, and it follows that oviposition

extends over a considerable period. Here in the District of Columbia the present year the first beetles that were noticed appeared late in April.[1] Larvæ were first noticed hatched May 11, but eggs were still to be found late in June.

Eggs deposited May 11 and 12 hatched May 19 and 20, or in eight days, the weather during this time being seasonable.

Larval habits.—The plants of dock on the Department grounds upon which beetles were placed were carefully watched and the stems and roots were pulled up for examination from time to time, but, unfortunately, the ants which were associated with aphides at the roots entered the burrows and killed the larvæ, thus interrupting our experiments. Stems of dock were also examined in the neighborhood about the District of Columbia and larvæ were found to approach maturity during the first and second weeks in July. July 22 an immature beetle was found in its burrow, larvæ and pupæ also being present in that vicinity at this time. The duration of the larval stage, although not definitely ascertained, is not far from two months.

It is probable from all that could be learned that larvæ begin to approach maturity about the first or second week of July.

Beetles put in our rearing cages in early May lived through June till about the middle of July, some, however, dying earlier; in other words, some of the hibernated beetles are still living within a few days of the time of the first appearance of the new generation.

In the stems of dock examined, only a single Lixus was found to develop in a stem. Often a dozen or more punctures are made in a stem and nearly as many eggs are deposited in some cases, but one larva only develops. What becomes of the other larvæ is a problem. Presumably they fall a prey in many instances to predaceous insects, particularly ants, but when they are not so destroyed it would seem that they either die from being shut off by the larva nearest the roots into the upper portion of the plant, where they succumb with the dying of the stem, while the lowest larvæ, having an abundance of moist food, survives. Very often the larvæ bore down into the root, evidently being driven to this expedient by the drying of the stems above.

Life cycle still incomplete.—From the above it will be seen that the full life cycle is not yet known. The egg stage, as previously observed, was eight days in seasonable May weather. The observed duration of the pupal period in the hot weather of July was also eight days. The observations on the life cycle period, and hence the larval period, which could readily have been made out by deduction, were interrupted by the ants.

The species does not appear to develop in rhubarb.—If the larva lives at all in rhubarb this fact has escaped observation. Many eggs fail to

[1]This is true, also, of *L. mucidus*, according to Weed.

hatch, presumably being destroyed by the superabundance of juice which exudes from the plant where egg deposit takes place, while the larvæ, if they hatch at all, meet death in the same way.

Of all of the many thousands of eggs of this species that were deposited within a few miles of the District of Columbia it is obvious that only hundreds produced beetles. None that were deposited in rhubarb appeared to develop. A large percentage that were laid in dock and that produced larvæ also died before attaining maturity. In addition to ants, parasitic insects must have destroyed their quota of larvæ. So it follows that, taking into consideration the number of beetles that fail to survive the winter, the species, compared with many others that could be mentioned, leads quite a precarious existence.

NATURAL ENEMIES.

Mr. Webster, writing of this curculio in stems of Helianthus, remarked that a great many of the larvæ were devoured by woodpeckers. Dr. Weed recorded the rearing at Columbus, Ohio, of a hymenopterous parasite of *Lixus mucidus*, *Bracon rugator* Say. These parasites develop at the expense of the larvæ, feeding externally upon them. When mature they spin brown silken cocoons in which to transform. As several Braconids are known to be parasitic on other species of Lixus feeding like the present one in stems, it is probable that one or more species attack *Lixus concavus*.

REMEDIES.

The use of arsenicals or other poisonous insecticides upon rhubarb during its growing season is of course out of the question. Fortunately the nature of the injury by the species is not as a rule serious. When, however, this curculio occurs in troublesome numbers it can readily be controlled by other methods. The beetles are so large and conspicuous, and so often occur freely exposed in the bright sunlight on the leaves, that they are easily detected, and as they are sluggish and do not fly readily there is no difficulty in capturing them. The proper time for this is upon the beetles' first appearance. It would be well also to gather the beetles upon near-by plants of dock, and after the eggs are deposited these plants should be pulled up and burned. In the District of Columbia and in similar latitudes the beetles are to be looked for toward the end of April and first of May, and the docks which serve as a trap crop should be destroyed about the first of July, as most of the eggs have been deposited by that time.

THE STRAWBERRY FLEA-BEETLE.

(*Haltica ignita* Ill.)

One of the periodical visitants of the strawberry bed, and an insect that can, in its periods of abundance, prove quite troublesome, is a Chrysomelid beetle, known in literature as the strawberry-leaf flea-beetle, or fiery flea-beetle. It has also been called the apple flea-beetle and the lesser grapevine flea-beetle, and is now known scientifically as *Haltica ignita* Ill., though often mentioned in text-books and agricultural works under the name of *Graptodera ignita*.

The periodicity of attack of this insect, coupled with the fact that it is not confined to strawberry, but feeds on a variety of other plants, including weeds—its natural and preferred larval food plants—render it unlikely that it will ever become of the highest importance. Of its capabilities for destruction more will be said under the chapters devoted to recorded injuries and literature and unpublished records of injuries.

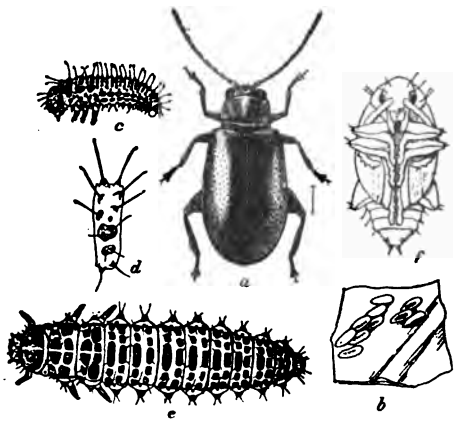

FIG. 17.—*Haltica ignita: a*, beetle; *b*, egg mass on bit of leaf; *c*, newly-hatched larva; *d*, first abdominal segment of same greatly enlarged; *e*, larva; *f*, pupa—all except *d* about eight times natural size (original).

DESCRIPTION OF THE SPECIES.

The strawberry flea-beetle belongs to the typical genus Haltica, of the tribe Halticini, or flea-beetles, a genus which includes 24 described species, most of them of a uniform greenish or bluish color, and all provided, as are other flea-beetles, with powerful, dilated hind femora. By means of their strong hind-legs the beetles possess an unusual saltatory power, which has given them the common name of flea-beetles.

Haltica ignita was given its scientific name by the German entomologist Illiger in the year 1807 (Magazin für Insectenkunde, Vol. VI, p. 117). It was described later under the specific names *kalmiæ* Melsh. and *inærata* Lec., and mention is made by Melsheimer and LeConte of two MSS. names, *cuprea* Melsh. and *splendida*, by which the species was also known in collections.

The various species of Haltica are difficult of determination without the aid of full descriptions and a large series of specimens, including the males. *H. ignita* is one of the smaller species and belongs to the same group as the grapevine flea-beetle, *H. chalybea*, which has the thorax with an antebasal groove extending entirely across. In the

present species the groove appears to vanish at each end, but this is apparent only. The punctuation of the elytra is coarse. The general appearance of the insect is illustrated at figure 17, *a*. It is of oval, slightly oblong form, and is remarkable on account of its extreme variability of coloration, the color of different individuals ranging from bright metallic golden, coppery, golden brown or purplish, to green and blue. The variation in color is of unusual interest, as it is influenced by climate and determines to a great extent the range of the species, this fact being so striking as to have attracted the writer's attention long ago and to have received special mention by Dr. Horn. The more northern individuals are the more brilliant golden-hued ones. About the District of Columbia the green ones are apparently more abundant, and are the prevailing types southward, deep blue becoming the characteristic color of the specimens taken in the Gulf States. It may be significant that the beetles observed by the writer before the middle of August the past season were mostly green and those observed in the same locality after that date were metallic. The latter, however, are not nearly so brilliant as those occurring farther north. The Northern individuals are, as a rule, larger than the Southern ones.

DISTRIBUTION.

The strawberry flea-beetle is a native American species and of such remarkably wide distribution as to have created remark by Mr. Martin Jacoby, a European authority on Chrysomelidæ.

The distribution of this species accorded by Horn, who gave a full technical description on page 221 of the Transactions of the American Entomological Society for 1889 (Vol. XVI, p. 221), is from the Hudson Bay region to the New England States, south to Texas and Florida.

The following locality list has been compiled from published and unpublished records, the latter, which includes most localities mentioned, being founded on material in the National Museum and the writer's own collection. It shows a range extending from ocean to ocean and from north to south of Canada to Mexico.

Newport, R. I.; Ithaca (July 5–9), Peekskill, Port Richmond, Staten Island (June 3), Carys Mills, Floral Park, N. Y.; Orange (at light), Highlands (June 18), and elsewhere throughout New Jersey; River View, Goldsboro, Marshall Hall, Md.; Norfolk, Rosslyn, Cherry Dale (June 3–July 11), Va.; District of Columbia; St. Louis, Mo.; West Point and Nebraska City, Nebr.; Columbus, New Albany, Indianapolis, Ind.; White Bear Lake, Minn. (Lugger); Waco, Cypress Mills, and Beeville, Tex.; Tempe, Ariz.; Orlando, Oviedo, Lake City, Valkaria, Waldo, Fla.; Easton, Wash.; Colorado; Sacramento, Cal.

To the above list there should be added: Atoyac and Vera Cruz, Mexico (Jacoby); Fort Simpson (LeConte) and Fort Rae (Wickham), Northwest Territory, Canada.

DESCRIPTIONS OF THE PREPARATORY STAGES.

The egg.—The egg is subcylindrical, and in outline rather irregularly elliptical, being about two and one-fourth times as long as wide at its greatest diameter. From the egg of *Disonycha xanthomelæna*, a flea-beetle which was figured and described in its different stages in Bulletin 19, n. s. (page 81), and which it somewhat resembles, it differs in having the ends reversed. It is narrower at the base, where it is somewhat irregularly rounded and longitudinally wrinkled on one or two exposures and is broader and more rounded at the apex. The color when newly deposited is pale yellowish buff, changing but little before hatching. The surface is opaque and the sculpture recalls that of Disonycha, but is more or less obsolete, in some eggs being very indistinct.

Length, 0.72 to 0.78 mm.; width, 0.32 to 0.35 mm.

The eggs are deposited in groups of two or three to twenty or more, side by side, in the manner shown in the illustration (fig. 17, *b*). They are rather firmly attached at their bases and lie upon the leaf nearly flat, but with their apical ends free. A very large proportion of the eggs obtained in confinement were streaked lengthwise with a thin line of excrement, and this would appear to be a normal habit of the female of voiding a small quantity of her fæces on each egg.

The newly hatched larva.—The larva when just hatched has the appearance represented at *c* of figure 17. It is subcylindrical in form and rather dull, dirty-looking honey yellow in color. It tapers strongly toward the posterior extremity and is widest near the middle. The head is large and prominent, with prominent three-jointed, conical antennæ. The legs are long and the body is covered with long gray and black hairs. The hairs proceeding from the head, and the longest of those which proceed from the sides of the prothorax and the lower portions of the sides of the abdominal segments, are normal and pointed. The majority of the remainder—those on the sides of the thorax and abdomen and at the ends—are bulbous or capitate, as is often the case with post-embryonic larvæ. The hairs proceed from tubercles which are only moderately prominent as compared with those of other related species. The second and third thoracic segments bear above two pairs of rather conspicuous black tubercles. The dorsal tubercles are also mostly black, small, and rather inconspicuous. The hairs proceeding from these are also black. The anal proleg is large and prominent and assists the larva in locomotion.

Length, 0.9 mm.; width, 0.4 mm.

The mature larva.—The larva resembles that of *Haltica chalybea*, the two possessing many features in common. That of *ignita*, when full grown, varies somewhat as regards the ground color, some few being dull yellowish, but more often the general color is dark olive, sometimes so nearly black that the tubercles can scarcely be dis-

tinguished, giving to the body a nearly uniform dull black color. The shape is subcylindrical, well-rounded above and depressed ventrally. The body tapers about equally toward either extremity, the diameter being greatest near the middle. The length is about four times the width. The surface of the body, both above and below, is very finely guttulate and very closely covered with large, dark tubercles, or tuberculous spots of various shapes. Some are single and some confluent, and bear, some one and some two hairs, the various patterns which they form on the dorsum being indicated in the illustration. All the tubercles appear black on the living larva, but in alcohol they turn dull greenish brown.

The head is rounded in outline, the lobes moderately constricted posteriorly and are indicated by a wide, shallow, median depression. The color is moderately shining black, with white sutural lines showing about the antennæ and mouth-parts, the inverted V mark is white and very thin. The hairs, which project a few forward and a few diagonally from its surface, are dark brown. The antennæ are black, and very short. The three pairs of thoracic legs are mostly black, like the antennæ on the exterior surface, and mostly gray on the interior, being for the most part gray toward the base and black apically.

FIG. 18.—*Haltica ignita:* ventral view of 1st and 2d abdominal segments, above; dorsal view of anal segment, below—both enlarged (original).

The thoracic plate is of the same ground color as the other tubercular surfaces but spotted with dark brown, and is surmounted with similar hairs. It has somewhat the appearance of being made up of several smaller tubercular spots. The median tubercles of the second and third thoracic segments are simple, but those of the abdominal segments are confluent and form an elongate, oblong transverse band. The anterior confluent pairs are about a third wider than the posterior. The tuberculiferous spots of the second and third thoracic are separated above by a narrow line moderately curved posteriorly.

The tubercular spots of the abdominal segments are arranged in moderately regular rows of eight; those above the spiracles being arranged in double and parallel rows; those below in single rows. All tubercles are prominent, the lateral being the largest and the dorsal the smallest. The tubercles above the spiracles bear each a single hair, blunt at the apex; the tubercles below the spiracles bear each two acutely pointed hairs, placed closely together.

In figure 18 the arrangement of the tubercles on the ventral surface of the first and second abdominal segments is shown above, and a dorsal view of the anal segment is given below. The anal proleg is moderately prominent and nearly white on its exposed surface.

Length of full grown larva extended, 5 to 5.6 mm.; width, 1.3 to 1.4 mm.

The pupa.—The pupa (fig. 17, *f*) in its structure presents no very observable characters for recognition. It looks like that of *Disonycha xanthomelæna* but differs in color. It is quite differently colored from its larva, being rather pale orange, with lighter yellowish orange head, legs, and wing-pads. The surface is rather sparsely beset with short, fine, acutely pointed hairs, light at their insertion and nearly black at the apices. These proceed from small, dark, rounded, moderately prominent piliferous warts or tubercles, in the arrangement of which there should be found good generic, if not specific, characters. One of these tubercles is located on the head near the inner angle of each eye, and another is placed above it and a little nearer the median line. A transverse row of hairs proceeds from the posterior end of each abdominal segment. The abdomen terminates in a pair of apical hooks, which are moderately acutely pointed and rather strongly incurved, nearly white in color at the base and black upon the posterior moiety. There is also on the ventral surface at each side of the anal aperture a minute tubercle.

Length, 3 mm.; width, 1.6 mm.

PUBLISHED BIOLOGIC RECORDS.

In the year 1847 Dr. F. E. Melsheimer gave to this insect the specific name of *kalmiæ* from its occurrence on the laurel, *Kalmia latifolia* and *glauca* (Proc. Acad. Nat. Sci. Phila., Vol. III, p. 164).

What appears to be the earliest record of injury to any useful plants by this species is that published in Volume III of the American Entomologist in 1880, and reported by Mr. G[eo]. T[hurber]. The beetles were described as having injured fuchsias at Norfolk, Va., in June of that year, when they swooped down "in a cloud," and in two hours ruined over 600 blooming plants; no other plants were noticed to be affected. Paris green killed the beetles, but unfortunately also injured the plants so that they could not be sold. In the answer to this letter by Dr. Riley, the species is identified as *Graptodera carinata* Germ., and the present identification of the species as *ignita* is on the authority of Mr. Schwarz. Incidental mention is made of the species having been found very injurious to fuchsias at St. Louis in 1874, and that it attacks also many other greenhouse plants. First appearance was noticed during the month of June. The egg was briefly described. The beetles were also stated to often swarm on fireweed (*Erichthites hieracifolia*). Pyrethrum "numbed" the insects and kept them off the plants until it was necessary to water them again. Beetles were reared from larvæ found feeding on evening primrose (*Œnothera biennis*).

It was not until a decade of years prior to the time of writing, so

far as can be ascertained, that anything was published concerning injury by the species to strawberry or other edible crops. In the year 1889 there was published in Insect Life (Vol. I, pp. 220, 221) a note from correspondence on injuries by the beetle to the tender leaves of grape at Tempe, Ariz., in April, 1886.

This was followed the next year by several publications concerning this flea-beetle, which will be briefly mentioned:

A line note on the occurrence of the species on Kalmia, at Peekskill, N. Y., early in May, by Mr. John D. Sherman, jr. (Proc. Ent. Soc. Wash., Vol. I, p. 162).

A second letter from the correspondence of the Division (Insect Life, Vol. II, pp. 369, 370), a complaint of injury by Mr. W. E. Hudson, Orlando, Fla., March 27, 1890. The beetles appeared on this correspondent's strawberries in thousands, and all the berry fields in the neighborhood were infested. They were also noticed on weeds of different species and on peach trees. They fed on the leaves from the upper side, eating off all the green part and leaving only the skeleton.

A short note by Dr. James C. Neal, stating merely that this flea-beetle had been the source of much trouble to strawberry growers in various sections of the State of Florida (Bul. 9, Fla. Agr. Exp. Stat., p. 11).

A note by Prof. Lawrence Bruner (Rept. of the Entomologist, Nebr. State Horti. Soc. for 1890, p. 23) containing, however, no original observations.

The following year, 1891, Prof. F. M. Webster (Bul. 33, Purdue Univ. Agr. Expt. Sta. Ind., p. 44) wrote of injuries by this insect at Columbus, Ind. What is practically a reprint of the last-mentioned note appeared the following year (Trans. Ind. Horti. Soc. for 1890 [1891], p. 25). This was followed by an article by Mr. Webster on the occurrence of this species at New Albany, in southern Indiana, reciting injury to strawberries, and including mention of damage occur ring as far north as Indianapolis. July and August were the months noted as the ones in which the beetles were most destructive, they seeming to disappear from the field about the 1st of September. A note by Mr. E. A. Schwarz (Proc. Ent. Soc. Wash., Vol, II, p. 183) appeared next, giving a review of observed food plants of the beetle. He remarked, among other things, that the imago appears to be more polyphagous than any other species of its genus, and that *Œnothera biennis* seemed to be the only true food plant ascertained for the larva up to that time. Brief mention was made in Volume V of Insect Life (p. 17) of injury that has previously been mentioned, adding, however, two new localities for the species—Lake City, Fla., and Waco, Tex. Omitting mere mention of the occurrence of this species on Kalmia by Dr. J. Hamilton, we come to an article published by Mr. A. L. Quaint-

ance in 1897 (Fla. Agr. Sta., Bul. 42, p. 592). No original observations were made, which is true of a note published by Prof. C. P. Gillette in Bulletin 47 of the State Agricultural College Experiment Station of Colorado (p. 5).

In Dr. Otto Lugger's fifth annual report as Entomologist to the State Experiment Station of the University of Minnesota, published in 1899, some attention is given this insect under the title of "The lesser grapevine flea-beetle." The insects were noticed by Mr. J. W. Taylor, White Bear Lake, Minn., early in the spring of 1899, eating into the buds of wild grape, afterwards attacking cultivated varieties, and later the foliage of Virginia creeper. After destroying the buds they continued upon the fully expanded leaves, which were riddled in every conceivable manner to such an extent as to destroy them entirely. Two generations were observed doing damage; the hibernating beetles commencing the work, and the larvæ and beetles of a subsequent generation finishing it. Eggs were found among the woolly substance of the partly destroyed grape buds. It is said of the species that it promises to become decidedly injurious, and therefore wherever it is found should be fought with arsenites as soon as noticed.

UNPUBLISHED DIVISIONAL RECORDS.

The unrecorded notes on injuries by this species are, like the published accounts previously noted, inconsiderable; but, such as they are, they tend to show the periodicity of attack, 1890 being a year of excessive abundance.

During 1890, specimens of the beetles were received from several localities with reports of damage to strawberry and other garden plants. April 4, from Mr. W. E. Hudson, Orlando, Fla., previously mentioned, as recorded; April 29, from Mr. John Scott, Waco, Tex., with the statement that the species was doing much damage to garden plants; September 1, from Mr. F. M. Webster, with the report that the beetles were injuring the strawberries at Columbus, Ind., also recorded.

Mr. T. L. Mead, an entomologist and a competent observer, wrote, May 4, 1897, that two or three years before that date a species of Haltica, which, from his description, is without doubt this species, "did a good deal of damage to strawberry leaves, being almost numerous enough to cover them." Locality, Oviedo, Fla. A spray of Paris green was used with apparently good results, as the next year the beetles were scarce and had not appeared at the time of writing. Mr. J. S. Lapham, Goldsboro, Md., writing of the occurrence of this flea-beetle on strawberry the same year, stated that "this insect feeds on the leaves, making thousands of small holes in them, and while it does not altogether destroy the crop of fruit, the berries are much smaller when it works."

HABITS OF THE LARVÆ.

In our rearing jars the larvæ hatched from the egg fed almost exclusively on the underside of the leaves. Not being satisfied that this was the only manner of feeding of the larva, a visit was paid to the locality where this species was found most abundantly the past season, with the result of finding some plants containing numerous larvæ. It was then ascertained that this larva lives very much as does the related *Haltica marevagans*, which the writer has had under observation in earlier years. It feeds upon both the upper and lower surfaces of the leaf, appearing not to prefer either side. It also erodes large holes in the growing seed pods, and even at times feeds in a similar manner upon the stem. The larvæ appear to favor the shade and are usually found in the more secluded positions on the plant, particularly the upper portions, occurring quite as often on the seed pods as on the foliage. In several instances larvæ were found that had crawled into leaves that had been rolled up by the grape leaf-folder, *Desmia funeralis*. The larvæ are quite sluggish and move from one leaf to another only when necessity urges them, feeding as they go. In feeding they gouge out around them large cavities, nearly as deep as their bodies.

When full fed the larvæ enter the earth, and beneath and near the surface form little cells for pupation. Before this transformation they become much lighter, yellow or orange-yellow, in color.

LIFE HISTORY OF THE SPECIES.

The beetles have been observed in the District of Columbia in May, but probably make their appearance in the South at least in April, and farther north may not appear till early June.

Eggs were deposited on the 23d by beetles obtained at River View, Md., May 21, and by others taken August 12, at Marshall Hall, Md., on the following day and until at least the end of the month, since eggs have been obtained as late as August 28.

The observed duration of the egg stage in August was six days.

Larvæ that hatched August 18 had begun to attain maturity August 29, or in eleven days, when they entered the earth for transformation.

The first imagos appeared September 6. We know even without verification the full periods of development merely by the analogy of this species and related ones. It had required two days for the beetle to mature before leaving the pupal cell. This would bring the date of assuming the imago state to September 4. The pupa stage required eight days, and eight days more were consumed by the larva in the earth before transformation to pupa. The temperature to which the insects were exposed during the major portion of this time was moderately cool, about 74 to 84° F.

Indications are that there are two generations produced annually in the District of Columbia, and there is probably a third in the South, while farther north only a single generation may develop.

NATURAL ENEMIES.

No parasitic or predacious insects have, to the writer's knowledge, been found to attack this insect, but it seems probable that since the larva lives freely exposed on its host plant that it is preyed upon by species of predaceous and probably also parasitic insects.

On some of the plants of evening primrose upon which larvæ were observed were numerous individuals of the spotted ladybird, *Megilla maculata*, and there are the best of reasons for believing that this is a natural enemy, although none of the ladybird beetles were actually observed to attack the flea-beetle larvæ during the time that the latter were under observation in the field.

REMEDIES.

In the treatment of the strawberry flea-beetle we have to follow much the same methods as previously prescribed in the case of the pale-striped flea-beetle. As with that insect, the best remedy is undoubtedly one of the arsenicals, Paris green or arsenate of lead being among the most useful, applied preferably in the form of a spray upon the first appearance of the insects in the gardens. As Bordeaux mixture is known to be a repellent of considerable value against flea-beetles, such arsenical as is used should be mixed with this fungicide. It will then serve also to a certain extent a double purpose of protecting the plants against fungous attack.

It is not desirable to use the poisonous sprays at the time of fruiting of the crop, and at this time dusting the foliage with lime would serve to drive the beetles away.

In cases where the beetles have been injurious for two or more years in succession, it would be advisable to apply the poisons to the wild larval food plants, and afterwards to prevent these growing in abundance where they would become an infesting source. It seems probable that most instances of attack could be traced directly to the beetles having bred in great numbers upon evening primrose or related plants growing in the immediate vicinity.

THE FALL ARMY WORM IN 1899.

(*Laphygma frugiperda* S. and A.)

Among the destructive insect pests of the season of 1899, and as troublesome, perhaps, as any insect of that year, if we take into consideration the large number of crops and the great area of territory affected, was the fall army worm, or grass worm of the South (*Laphygma frugiperda*, Smith and Abbot). The season was marked by unprecedented outbreaks over a very considerable portion of the United States east of the Rocky Mountain region, injury being reported

also in Cuba. The territory infested during the year comprised portions of New York and New Jersey in the North and East, and from there southward to Florida, and westward to Texas, including among Western States, Kansas, Nebraska, Ohio, Indiana, and Illinois.

Although the species is a common one, and known to husbandmen generally as distinct from the true army worm (*Leucania unipuncta* Haw.), its life history has not as yet been studied in all its details in any single locality, to the writer's knowledge. It is hoped during the coming season to settle certain points as to the insect's life habits and economy; and as the insect is one of great and growing importance, it is proposed to bring together all the most salient facts concerning it, in the form of a bulletin, when the missing data have been supplied. In the present paper a brief account of injurious occurrences of the season of 1899 will be furnished, together with a mere outline of other matters pertaining to the insect, pending a more complete account.

The fall army worm is essentially a grass feeder, attacking grasses of all sorts, as well as the most succulent grains, but when these foods are exhausted, as happened during the past year, the caterpillars, driven by hunger, avail themselves of almost anything green, and at such times become pests in gardens, orchards, and greenhouses, as well as in the field. Although, properly speaking, a field-crop insect, this species does such considerable damage in the vegetable gardens, and to so great a variety of truck crops, that it is for purposes of convenience considered in the present bulletin.

The list of localities where outbreaks were noticed duing the year, although large, does not by any means afford ground as to a full estimate of the ravages of this pest. Many correspondents reported the "army worm" in their vicinity where it was impossible to obtain specimens of the insect. As only four reports reached us during the season of injury by the true army worm, there is every reason to believe that the fall army worm was the insect present in nearly every case. Reports of injury by this insect usually attract attention late in the season, and for this reason only a single publication on this subject, emanating from the University of Nebraska, appeared during the year.

INJURIOUS OCCURRENCES OF THE SEASON OF 1899.

The first instance of reported injury was received from a correspondent who wrote June 19 of damage to the rice crop in the neighborhood of Wilmington, N. C. In this case, as in others which will be reported, specimens accompanied the communication.

During July we received a report of an outbreak at Cherry, N. C., and of much damage to corn, rice, peas, grasses, and young corn. During the latter days of that month the writer's attention was called by Dr. P. B. Kennedy, of the Division of Agrostology, to injury to an experimental plat of creeping bent-grass, *Agrostis stolonifera*, on the

Department grounds, in which this insect was concerned, and was evidently the chief factor concerned in the subsequent death of the grass.

During August we received through different correspondents reports of injury at Arcola, Ill., to leaves of corn; at Red Springs, N. C., to corn, millet, cowpeas, sweet potato and other vegetables; at Chicago and Evanston, Ill., of much trouble caused by the great numbers of these insects to lawns in both cities, this outbreak forming the text of numerous newspaper accounts and much correspondence with this Division; attack was most noticeable, from what could be learned, on young blue grass, although the "worms" were observed also on white clover; at New Glatz, Md., to forage or sowed corn and spinach; at Rives, Md., to millet; at Evansville, Ind., to corn; at Richmond, Va., to corn and millet near that city; at Statesburg, S. C., to grass, hay, and garden vegetables; at Morgantown, W. Va., to lawns; at Clarcona, Fla., to "teosinte," *Euchena mexicana*, a forage plant resembling maize; and at Congaree, S. C., to upland rice.

In October we received report from Athens, Ga., of injury to the leaves of turnips, in which this insect was one of the species present. At Mafanzas, Cuba, it was reported as being concerned in a severe attack upon pasture grasses, as well as on young tobacco. It was reported the same month as doing injury to lawns at Buffalo, N. Y., while at McPherson, Kans., it was stated to be destructive to wheat. Certain reports reached this office after the close of the year, and among these one from Mr. F. M. Webster of injury during the season at Haverhill, Buckrun, and Urbana, Ohio, and one from Prof. J. B. Smith of injuries in New Jersey, clover, grass, and wheat having been the crops attacked.

A more complete list of localities could have been furnished at this time but for the fact that the ravages of the insect were either at their height or had not been noticed at the time of the meeting of the Association of Economic Entomologists in August. Doubtless during the coming year different members of that Association in various parts of the country will write concerning the outbreaks in their respective States.

In The Indiana Farmer of September 22, 1899, this insect was reported as having made its appearance at New Lafayette, Ind., and in the vicinity of Indianapolis, corn, millet, buckwheat, and garden vegetables being the crops attacked.

In the publication of the University of Nebraska, previously mentioned (Press Bulletin, series No. 2), Prof. W. D. Hunter, its author, reported injury to be very severe in that State, particularly to alfalfa, the species having been identified from Johnson, Gage, Nemaha, Saline, Fillmore, Douglas, Washington, and Dodge counties. The presence of the species was also reported from Boyd and Dawson counties.

Other crops affected were beets, corn, Kafir corn, wheat, oats, cabbage, and grasses.

DESCRIPTIVE.

For the benefit of those readers of this bulletin who may not have access to descriptions and illustrations of the insect, brief descriptions will be furnished to serve as a means of identification in connection with figure 19.

The parent of the fall army worm is a moth and a member of the family Noctuidæ to which belongs the true army worm and the cutworms. The army-worm moth is quite unlike that of the common army worm and very variable, there usually being in most localities two distinct forms, a dull gray and an ornamented form. The former is shown in the illustration at *a*. The fore-wings are dull grayish-brown above and show in this color variety a pattern more or less like the one figured. The hind-wings are glistening white with rosy reflections. In the more ornamental form, the insect resembles one of the owlet moths, particularly *Prodenia ornithogalli*. The fore-wing of this variety is figured at *b*. The fore-wings are mottled with black and white, reddish brown, and sometimes with pale bluish, yellowish, and other tints. The wing expanse is from an inch to an inch and three-eighths.

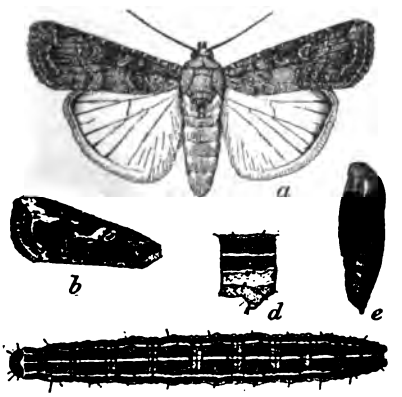

FIG. 19.—*Laphygma frugiperda:* *a*, moth, plain gray form; *b*, fore-wing of Prodenia-like form; *c*, larva extended; *d*, abdominal segment of larva, lateral view; *e*, pupa, lateral view—*d*, twice natural size; others enlarged one-fourth (original).

The eggs are about half a millimeter, or about one thirty-second of an inch in diameter, and are deposited in clusters of from fifty to sixty and more, often in two or three layers. The whole egg mass is covered with gray-colored down from the body of the parent moth.

The larva when first hatched is quite unlike the full-grown caterpillar, the head being proportionately larger and the body more hairy. It is nearly black at this stage. The same variability observed in the mature insect holds good of the coloring of the caterpillars. When mature they measure about an inch and a half, and while resembling the common army worm in certain particulars may readily be distinguished from that species. A full-grown caterpillar is shown in the illustration at *c*. The notable points of difference between this larva and the common army worm are in the larger and more prominent piliferous tubercles and the longer hairs of the former and in the

smaller and slenderer body. The head is proportionately smaller, nearly black, and with a white inverted Y-shaped mark in front not possessed by the army worm.

The body is striped on a ground color which varies above from pale yellowish brown, to black, more or less strongly streaked and intermixed with dull yellow. Three thin stripes of pale yellow extend along the dorsal surface through the thoracic shield to the anal extremity. The dorsal or middle line is nearly straight, and the subdorsal ones are feebly sinuate. On each side there is a broad yellow undulating line, more or less strongly mottled with red, particularly in the vicinity of the abdominal legs. The ventral or lower surface is paler, varying from dull yellow to greenish, sometimes very strongly mixed with red.

The pupa resembles that of the army worm, but is of smaller size, and the spiracles and a considerable proportion of the surrounding tissues are larger and more prominent in the former. The length in this stage is about five-eighths of an inch.

DISTRIBUTION OF THE SPECIES.

The distribution given by Dr. Smith in 1893 (Bul. 44, U. S. Nat. Mus., p. 169) is from "Canada, south to Florida and Texas, west to Missouri, Nebraska, Kansas, Jamaica, Brazil." The insect has also been reported to us from Colorado and Montana, and specimens were received during the year from Cuba.

The species is native American and probably indigenous to the United States, but has, evidently, spread from the Gulf States northward in rather recent years. At present it occupies the Tropical, Lower Austral, and Upper Austral life zones, and has been reported to occur in the Transition faunal area, and appears to be traveling slowly still farther northward.

HISTORY AND HABITS.

The fall army worm was first described in 1797, in Smith and Abbot's Natural History of the Lepidopterous Insects of Georgia, or one hundred and two years before the present general outbreak. Since that time ravages have been noticed at various periods and in different localities, in 1845, 1855, 1868, 1870, 1872, 1873, 1881, and 1883, these irruptions being noted in only one or two States in a single year.

The first outbreak of any extent occurred in 1884, followed by a smaller outbreak in the ensuing year. Later reports of injury were received in 1892, 1896, and 1897.

The list of plants which serve as food for the fall army worm during its periods of abundance include, besides grasses and grains of all sorts, sugar cane, buckwheat, alfalfa, clover, cowpeas, sugar beets, cotton, tobacco, sweet potatoes, spinach, turnips, tomatoes, cucumbers, cab-

bage, beans, and strawberry. Under exceptional circumstances vineyards are attacked and the foliage of fruit trees devoured, and instances are on record of invasions of greenhouses and of attack to stacks of fodder. The cannibalistic habit of the larvæ is well known, in which respect this insect resembles the boll worm.

The life history, as previously intimated, has not yet been carefully studied, the stage in which hibernation takes place being still in doubt. It was ascertained that hibernation does not take place in the egg condition, at least in the latitude of the District of Columbia, and it seems propable from all available data that this insect resembles the cotton worm (*Aletia xylina* Say), at least in its habit of hibernation. From specimens received during the past season from Georgia, adults were obtained during a warm spell in November, and it is the consensus of opinion of those who have given the subject of the biology of this insect any study that it probably passes the winter either as adult or as pupa, and from present knowledge evidently in the adult condition chiefly, although it is possible that larvæ may winter over.

The number of generations produced each year has been stated to be at least two in the northern limits of the species, and three for the south; but, from experience with related insects, the writer is inclined to accord this insect at least three generations for a climate like that of the District of Columbia, and four or more for the Gulf States. It is hoped that another year may see these points, as well as others, in the insect's life history made clear; as, for example, the time of the earliest appearance of the moth in different localities, the time of first egg-laying, and the period of all of the different stages, and the stage and place of hibernation.

The larvæ live like other cutworms in years of ordinary abundance, and are so dark and evidently secretive in their nature as to usually escape recognition. When, however, in seasons like the past, an undue increase in the numbers of the insect takes place and the habit of moving in armies is assumed, their presence becomes manifest, too late, however, in most instances, for remedial treatment.

Transformation to pupa takes place in little earthen cells, which may be either erect or somewhat inclined, but occasionally pupæ are not so protected.

A feature of the fall army worm's attack, and the one from which it has received its name, is that it is seldom observed to travel in numbers, save perhaps in the extreme South, until the fall, at least not earlier than the first of August, while the outbreaks of the common army worm occur usually prior to that time and seldom later.

NATURAL ENEMIES.

The fall army worm, on account of its somewhat smaller size, less conspicuous appearance and more concealed manner of living, and from

the fact that it is not usually found in such large armies, does not attract the same number of parasitic and predaceous enemies that have been recorded for the common army worm. During the past season the only natural enemies of the fall army worm observed were the English sparrow and some other birds, especially flickers, and a Tachinid fly, *Winthemia quadripunctulata* Wied.; which deposits its eggs usually on or near the thoracic segments of its victim. A few other natural enemies have been observed in other years, which include ants, wasps, Ichneumon flies, and Chalcidids.

It is well known that two outbreaks of the true army worm have never yet come under observation in successive years, and it is to the efficiency of natural enemies that such a condition is ascribed. From the experience of the past year there is no reason to expect immunity from attack the coming year, as scarcely any dependence can be placed upon parasitic and predaceous insects and other animals with this species, and we know moreover that outbreaks may occur in successive years, as happened in Florida in 1896 and 1897, and in two other cases which have been recorded.

REMEDIAL MEASURES.

The fall army worm resembles so nearly the common army worm in seasons when it assumes the habit of traveling in armies that it is at such times amenable to much the same line of remedial treatment. The remedies of the greatest value against the latter are described in the Annual Report of this Department for 1879 (pp. 189, 190), and in Circular No. 4, second series, of this Division (pp. 3, 4).

Unfortunately, as with the common army worm, infestation is not reported, in fact is seldom detected, until too late for the application of direct remedies. When attack is at its height the larvæ or "worms" are usually approaching maturity, and it is difficult to check them at this stage or prevent them from passing from one field or garden to another. Paris green and other arsenicals are of value where they would not involve further injury to the crop infested or destroy it as food for man or beast.

Lawns can be freed from the caterpillars, at least in great measure, by the use of kerosene emulsion followed with as complete a drenching as possible with water from a hose.

If the earlier generations of the caterpillars could be discovered they could be destroyed in the same manner as other cutworms by the use of poisoned baits, this remedy being particularly applicable in vegetable gardens. Such baits should be made of succulent grasses or alfalfa, where the latter can be obtained, and saturated by immersion in a solution of Paris green or other arsenical.

By copiously spraying a wide strip of grass land surrounding unin

fested areas with Paris green, the insect could be prevented from spreading to them.

Rotation of crops should always be practiced, as well as the burning over of fields in the fall when the crops have become too badly injured for recovery. It is even advisable to burn over crops and to plow up fields just as soon as permanent loss is assured, and thus prevent infestation of neighboring crops.

Above all other precautions it is necessary to keep fields free from volunteer grain and wild grasses that would attract the moths for the deposition of their eggs, and thus serve as a breeding ground for the insects. A potent source of injury is the planting of one cereal after another with grasses, and the planting of crops in ground which has been permitted to run waste to wild grasses and weeds.

Before planting to grass and cereals the soil, particularly in the fall, should be thoroughly broken up by plowing and harrowing. Fall plowing is always to be practiced where suitable to the crop, the soil, and other conditions, and it is also well to follow with a harrow and level the ground where possible. For alfalfa, Professor Hunter recommends "disking," and for lawns a thorough going over with a long-toothed steel rake. Such methods of treatment serve to break up the cells in which the chrysalides are resting, as well as to destroy the larva when present in its several stages.

From the observations of Dr. Howard on the occurrence of this insect in 1881, it would seem obvious that where rice fields can be flooded many of these insects will be destroyed, and in localities where flooding is practicable there need be little fear of injuries. In many cases it is possible to overflow the fields at will, and, where necessary, negro laborers can be sent through fields to brush the "worms" from the stalks and leaf blades into the water.

During the outbreak of 1884 in Kansas it was learned that the ravages of this insect could be prevented by postponing the planting of wheat and rye until between September 20 and October 20.

THE STRAWBERRY CROWN MOTH.

(*Sesia rutilans* Hy. Edw.)

A destructive enemy to small fruits in the Pacific States and one particularly injurious to strawberry, blackberry, and raspberry in California is a borer larva of the Sesiid moth, *Sesia rutilans* Hy. Edw. Although the species has not often come to the notice of this office through correspondence, it has received some little attention at the hands of western entomologists and has already a considerable literature. Of recent reports of injury we have only one, that communicated by Mr. A. F. Bowen, Mountain View, Cal., February 26, 1900, when specimens were sent of crowns of strawberry that showed injury

by the larva, which was also present and included in this sending. Our correspondent wrote that while examining the plants last autumn he found that in disturbing the vines a clear-winged moth (the parent of this borer) often flew out.

As this insect does not appear to have received notice, even casually, in any of our official governmental publications, the present paper has been prepared.

INJURY AT SANTA CLARA, CAL.

Among the insects collected several years ago by Mr. A. Koebele while acting as special field agent of this Division in California this species was prominent.

April 22, 1887, Mr. Koebele found numerous specimens of this species, at that time in larva and chrysalis form, in the roots of strawberry at Santa Clara, Cal. In the field examined about one-half of all the plants were infested. Injury became manifest only after the old main root was destroyed. All the chrysalides observed were in cocoons formed of bits of roots within the roots and near an opening. The mature moths began issuing April 30, and continued until July 2, being most numerous toward the end of May.

May 26 of the following year Mr. Koebele made a careful examination of the same field in which the insects had been observed previously and noticed a general improvement. In places where plants had been killed, many new ones had come up and larvæ and pupæ were exceedingly rare. This was believed to be due to the free use of water during the preceding spring, which resulted in the destruction of the larvæ, many dead and moldy specimens of which were found, as well as some which were parasitized. From material gathered at this time adults were again reared, the last individuals issuing July 24. Among this lot was an unusual variation, which Mr. Koebele described as being entirely black. July 14 of the same year this species was reared from raspberry. The larva was found boring in the roots up into the dead stump, pupating about one inch above ground.

BIOLOGIC LITERATURE.

The first record that I find of the habits of this species is that published by Mr. J. J. Rivers, in Volume III of Papilio (p. 26), in January, 1883. This is a short note from correspondence, and is headed *Ægeria hemizoniæ* Hy. Edw. It is quoted in full:

> I have reared this species from the larva, a pallid grub with a darker head, feeding in the roots, rhizome, or base of the canes of the cultivated raspberry, and devouring the pith therein. This is looked upon by fruit growers as a direful insect, killing the plant, root and branch, but the injury is not so great as supposed. The larva feeds only on the pith, the loss of which is not immediately fatal, even to the part affected, much less to the whole. I have observed these Ægerian larvæ always in

otherwise unhealthy plants, such as are infested with "scale," and mostly with the tumors of the "woolly aphis" upon their roots. This last condition is usually accompanied by bad cultivation.

In the Pacific Rural Press of June 25, 1887 (vol. 33, p. 559), a letter by Dr. Riley addressed to Mr. I. A. Wilcox, Santa Clara, Cal., is published. The species is here mentioned as *Ægeria impropria* Hy. Edw., by which name it also received mention in most subsequent publications bearing upon the biology of this insect.

At a meeting of the Entomological Society of Washington, held June 2, 1887 (see Proceedings, Vol. I, p. 85, published March 1, 1888), specimens of the several stages of this species were exhibited by Dr. Riley with the statement that it was injurious in the larval stage to strawberries in southern California. He stated that he had for several years known that great injury to the roots of strawberry was occasioned by some lepidopterous borer, but the species had remained undetermined until about that time.

In 1888 Mr. W. G. Klee, State inspector of fruit pests, gave a popular account of this species in the Third Biennial Report of the State Board of Horticulture of California for that year (pp. 243, 244). This includes an illustration of the three stages of the insect and a statement that the common practice of flooding the vines has a great tendency to kill out the insect when in the larval stage, the opinion being expressed that if the water were retained for four or five days during the winter over the plants all larvæ would probably be killed.

In August of the same year Mr. Rivers published a second note on this insect with an account of its occurrence in the roots of cultivated blackberry. It was found equally at home in this plant, and caused the foliage and fruit to be dwarfed, dried, and valueless. (Entom. Amer., Vol. IV, p. 99.)

Recently Messrs. C. V. Piper and R. W. Doane gave a popular economic account of this species in Bulletin 35 of the Washington State Agricultural Experiment Station, dated May, 1898 (pp. 13–17), and during 1899 a short general account by Dr. Otto Lugger was published in that writer's Fourth Annual Report as Entomologist of Minnesota, page 64.

DESCRIPTION OF THE SPECIES.

According to recent studies of Mr. Beutenmüller on the Sesiidæ of North America, the insect in question must be referred to the species described by Henry Edwards in November, 1881, in Papilio (Vol. I, pp. 186, 187), under the name of *Albuna rutilans*. The type was a single female captured at Virginia City, Nev.

The adult, like other species of the Sesiidæ or clear-winged moths, is noticeable on account of the transparency of the wings, particularly of the hinder pair, the slender body, and the tuft of the apex of the abdomen, which, in life, is spread out like a fan. The moths are

diurnal in habit, flying swiftly in the heat of the day, when they might easily be mistaken for wasps, an effect due to their slender form, transparent hind-wings, and bright metallic colors.

The female moth is shown in the figure at *a*. It has a wing expanse of about seven-eighths of an inch (18 to 22 mm.). The ground color of the body and head is black with yellow stripes and bands. The antennæ are bluish black, and the legs are yellow ringed with black. The fore-wings are broadly bordered with brown and black, with a purple iridescence. Between the veins are thin stripes of yellow. The outer border of both wings is fringed with brown, that portion of the hind-wings nearest the base being fringed with yellow. The abdomen is tufted at the tip with yellow and black.

The male (*b*) is similar, but smaller and more slender, the anal tuft being longer and wider and blue-black in color.

A full description with bibliography and notes is given by Beutenmüller (Bul. Am. Mus. Nat. Hist., Vol. VIII, pp. 130, 131, 1896).

The remarkable variability of this species is illustrated by the number of names that have been given to it by its original describer. According to Beutenmüller, the synonyms are *Ægeria aureola*, *hemizoniæ*, *lupini*, *perplexa*, *impropria*, *washingtonia* and *maderiæ* ♂, all described in volume I of Papilio.

The present known habitat includes Marin and Mendocino counties, and Sierra Nevada, Santa Clara, and Sausalito, Cal.; Virginia City and elsewhere in Nevada, Washington, Colorado, and Texas. The species is obviously native, and as the last-mentioned locality is based on a single male collected many years ago, either there is some reasonable doubt as to the authenticity of the capture or the species has a rather unusual range for an indigenous insect.

EARLIER STAGES DESCRIBED.

In the accompanying illustration the immature stages were drawn at the time of the receipt of the specimens; the adults were finished more recently.

The larva.—The larva, shown in the illustration at *c* at work within a strawberry stem, is of the usual cylindrical form and white color of the Ægerians and of nearly uniform diameter from the first thoracic to the last two abdominal segments, where the body tapers strongly. The second thoracic segment is just perceptibly widest, a little wider than the middle abdominal, and the last joint is quite narrow. The head is reddish brown and partially concealed beneath the first thoracic segment. The mandibles are black and the legs brownish with small dark-brown or black claws. The body has a few small brownish hairs scattered over each segment. In a general way this larva very closely resembles congeneric species, such as *pyri* and *acerni*, being of about the same size as the former. The length is about $\frac{6}{10}$ of an

inch (15^{mm}) when contracted, and $\frac{8}{10}$ of an inch (20^{mm}) when fully extended, the width being a little less than an eighth of an inch (3^{mm}).

The pupa, or chrysalis (see *d*), is formed in a cocoon which the larva spins about itself early in June—in Washington State, constructed principally of brownish castings woven together by means of fine silken strands. The chrysalis itself is reddish brown in color, about one-half inch long and with several rows of blackish spines crossing the back, the last row being larger and extending further around on the sides. The wings, antennæ, and long sucking tube may be seen folded underneath the body.

The cocoon is constructed within the burrow of the larva, and usually made near the center of the crown of the plant; but just before the emergence of the moth, the pupa, like others of its kind, and with the assistance of the sharp spines on its back, wriggles its way partially out of the cocoon, and after the escape of the moth the empty pupa skin is left projecting from the former home of the larva, as shown in the illustration at *e*.

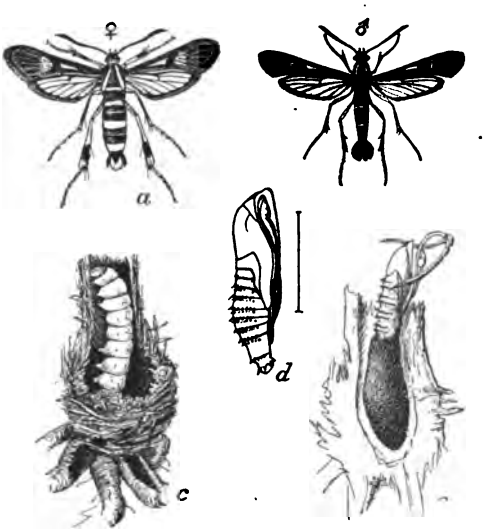

FIG. 20.—*Sesia rutilans*: *a*, female moth; *b*, male; *c*, larva at work in strawberry stem; *d*, pupa; *e*, pupal cell in stem, showing empty pupal case after escape of moth—*a*, *b*, *c*, *e*, about one-third enlarged; *d*, twice natural size (original.)

METHODS OF CONTROL.

Submersion.—From the observations of Messrs. Koebele and Klee, it is evident that the submerging of affceted fields, where this can be accomplished, is sufficient, when properly done, for the suppression of the pest. This means of control is particularly applicable in localities where irrigation is practiced, the best time for submersion being, theoretically at least, as soon as possible after the fruit has been gathered.

It would be interesting to learn how common this practice is, and just how practicable it may be in the regions most affected by the insect.

Insecticides valueless.—Where submersion cannot be practiced, it would appear that remedial measures will be very difficult of application. In fact, we are confronted by much the same difficulties that present themselves in our efforts to control the nearly related squash-vine borer. The concealed mode of life of the larva renders the use of insecticides practically out of the question, the only one that would

give any good results being bisulphide of carbon, and it is doubtful if this could be applied profitably. The pupa is equally difficult to reach.

Protection with netting.—Choice plants, it is true, could be protected by means of close-mesh netting, which should be applied just before the appearance of the moths in July and retained in place until after the period of ovulation.

Cutting out infested and weak plants.—For the most efficient means of control in the absence of the practicability of submersion, we must have recourse to the heroic treatment which has already been recommended by Piper and Doane, and which consists in watching the plants closely for evidences of injury in the early spring, and then digging out and destroying by burning all infested or weakened plants that might serve as a breeding place for the species. After the plants have served their usefulness, they should be plowed under. It would be well to look carefully over all wild or volunteer growth of all of the known food plants of this species, and to pursue the same methods with these, destroying all useless plants.

THE BLACK GOOSEBERRY BORER.

(*Xylocrius agassizii* Lec.)

December 27, 1898, Dr. James Fletcher, entomologist and botanist of the Dominion of Canada, wrote that a Longicorn beetle, *Xylocrius*

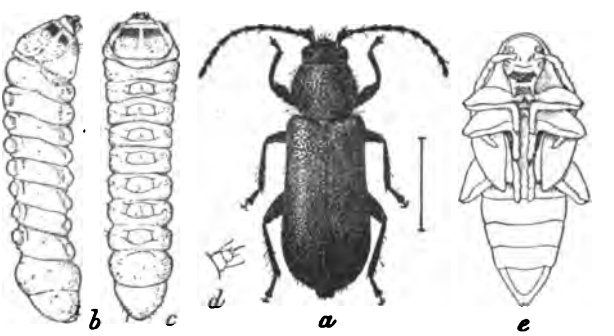

FIG. 21.—*Xylocrius agassizii*: *a*, beetle; *b*, larva, lateral view; *c*, same, dorsal view; *d*, larval antenna; *e*, pupa —*a*, *b*, *c*, *e*, three times natural size; *d*, more enlarged (author's illustration.)

agassizii Lec., had recently been reared from a larva imported from Oregon into British Columbia, and found boring the stems of gooseberry. Injury by the species was detected by some of the stems breaking when being handled. All of the consignees of this particular stock were visited, and Dr. Fletcher believes that the bushes were inspected before the beetles could have emerged.

From specimens furnished by Mr. E. A. Carew-Gibson, Victoria, British Columbia, the accompanying figure 21 was made by this Divi-

FIG. 22.—Gooseberry stem infested by *Xylocrius agassizii*—reduced one-third (from photograph by E. A. Carew-Gibson).

FIG. 23.—Gooseberry stem showing larva of *Xylocrius agassizii*—slightly enlarged (photograph by Carew-Gibson).